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PROFIT-MAKING IN SHOP AND FACTORY MANAGEMENT

By C. U. Carpenter.

I. THE REORGANIZATION OF A RUN-DOWN CONCERN.

Mr. Carpenter's article this month is introductory to a series which will be of great practical value because it will be an intimate presentation of methods which have met with unqualified commercial success. He does not attempt in this number to do more than point out the most serious defects of the ordinary business organization. Succeeding papers will deal quite fully with the suggested methods of betterment.—THE EDITORS.

IN this present day of prosperity, with manufacturers behind their orders, running full forces night and day, straining every nerve to increase production and being further embarrassed by a constant influx of new business, the consideration of the problems confronting a " run-down " concern and the ways and means of correcting its serious defects in organization, methods, and systems may not, upon first thought, appear " timely."

I contend, however, that the present is the time to attack and solve these problems. Experience and investigation have disclosed an amazing number of concerns which, even under existing conditions, are having none too easy a time in making headway. Many manufacturers today have an uncomfortable sensation of uncertainty concerning the progress and profits of the establishments under their management.

Any manufacturer feeling the existence of unsatisfactory and unprofitable conditions must make up his mind that the real reasons for them must be discovered and the causes removed at any cost; for should the management, in its conduct of the business, not discover its weaknesses, this same management may be sure that some

thoroughly organized competitor will drive the condition to their startled attention when more severe seasons of trade come upon us.

Necessity for Analysis.—To solve the problems confronting him, a man must bring to them an absolutely unbiased mind and a determination to analyze the situation thoroughly and mercilessly, and so to form an accurate judgment as to the underlying reasons. You, the manufacturer, may be sure that unless your factory, selling, and executive organizations can stand this test of your coldest and most searching examination—your analytical test—you will, when the present expanding conditions of trade change, find the foundation of your business slipping from under it, slowly perhaps, but surely.

Advantageous Position of a Well Organized Concern.—We hear much today of the advantages that one competitor secures over another through the "secret rebate," special "shipping privileges," unfair "rate classifications," "secret agreements," etc. In a manufacturing business these advantages count for little against a company with an effective organization of the working force, stimulated by a desire to work not only for self but also for the good of the concern, aided by up-to-date mechanical methods and modern tools especially adapted to the quick, accurate, and economical manufacture of the parts to be produced; supported by comprehensive, though simple, systems that enable the management to keep an accurate check upon the cost of production, and also enable them to determine the proper course to pursue in order to secure still greater economies—a system of manufacture that enables the management to feel certain that the most economical methods of production are being planned and pursued.

Add to this an efficient selling force, properly trained by modern methods, and an economical plan of putting the manufactured goods upon the market, and the firm possessing such advantages is in an impregnable position.

The Manufacturer "With His Eyes Closed."—In this day, a firm must adopt the most modern methods in organization, method and system to hold its own. Reputation gained in the earlier days of a firm's existence is a valuable asset when backed up by modern methods, but amounts to little when it is coupled with obsolete ways of doing business. A business must progress or slide backward. It cannot stand still. The manufacturer can always feel certain that if he is not progressing some one of his competitors surely is. This he may learn to his sorrow. As I said in a former article, the old maxim "a stern chase is a long one" applies with peculiar force to business conditions. Once your competitor has built his tools for

economical production, improved his product, organized his forces, and secured the proper start on the market, his sales and profits multiply and yours decrease. And the longer you delay adopting similar methods, the more the difficulties increase.

There are still many manufacturers who are not satisfied to give their unqualified approval to modern methods in shop and selling organization. The number is growing less every day, but there are thousands to whom these remarks yet apply. To these the very word "organization" implies something mysterious—something big, and certainly something expensive. The idea of "organization" is not compatible with their idea of economical management. To these the idea of "system" is indissolubly linked with "red tape." "System" to them means additions to their clerical force, and additions to their clerical force mean additional dollars spent upon "non-producers." They will refuse to admit the advisability of systems sufficient to care for their heavy factory interests, and yet they have sufficient intelligence to keep up their general accounting system. In brief, they do not note the tremendous leaks in their factories because they have not sufficient experience or data to enable them to know, with any degree of exactness, whether or not they are getting proper and economical results from either foremen, men, or machinery. A moment's thought must make such as these realize the possibilities of the existence of such leaks, and they may be absolutely certain that where such possibilities exist, unchecked and unsystematized, there also exist the losses.

The Manufacturer "With His Hands Tied."—There are, however, many manufacturers today who realize that something is wrong, seriously wrong, and who would be glad to apply modern methods if they but knew what they were and how to apply them. But to many a man who is intent on improving conditions, but who necessarily faces ignorance, prejudice, false pride, and stubbornness on the part of those in his organization who should help him, the job is appalling. To such, however, as recognize the conditions and are willing to attack the problem methods can be suggested, the value of which has been proven over and over in actual experience under the most distressing conditions. Careful investigations, coupled with a thorough campaign of action along organized lines, will bring the reward.

The Reward.—The reward for such investigation, coupled with vigorous, intelligent, and tactful action, is so great as to justify the expenditure of any amount of labor and time. That it will take time,

and in most cases a long time, is very true; but that is all the more reason for beginning and continuing courageously along steady lines of progress, and in such a manner that any backward step would not be possible. The most difficult and discouraging problem to contend with, next to the difficulty of wheeling the old men into line, is that of progressing along new lines, devising and putting into effect new methods and new processes and tools, and at the same time not interfering with the regular required output. However, if the manager is sufficiently impressed by stern necessity to lay out plans for improvement, every one upon whom he must depend must be impressed with the idea that *every day* must show *some progress,* however slight, on the part of every one connected with the plans.

Analysis.—As stated before, nothing can be done on any case until the manufacturer, and such advisers as are qualified and trustworthy, approach the problem in an absolutely unbiased frame of mind. They must make up their minds to analyze coldly each and every man and situation. The problem may be attacked as outlined hereinafter.

Let us consider the defects in organization, system and methods, in their order, and attempt to discover the " sticking points " in each division. They may be classified as follows:—

1. Defects of factory organization, dealing with the superintendent, the foremen, the job bosses, and the workmen, and the usual methods of management.

2. The defects of systems and methods of manufacturing.

3. The defects of sales organization and executive control.

The separations made herewith are important ones and should be considered as thoroughly in the case of the concern with fifty men as in the case of the one with five thousand.

Organize your " Method of Investigation."—If you are interested, take this list item by item and make a faithful memorandum of the defects under each heading that you alone know of. If you have such a knowledge of the business as you should have you will be surprised at the number of your notations. Then when you come to the headings of those processes with which you are not familiar, secure the advice of competent persons in each line and then note the extent and character of your notes.

DEFECTS OF ORGANIZATION AND METHODS OF MANAGEMENT.

The Superintendent.—Singularly enough, the method of management usually adopted is that of placing all the responsibility on the shoulders of one superintendent and failing to surround and

strengthen him with a small body of the most efficient foremen, who might prove to be advisers of great value to him. In adopting such a method, the management fails to recognize the great benefit to be derived from securing the best advice of a small group of the best qualified men upon most important subjects, and from giving its foremen an opportunity to increase their knowledge of the business and so to grow to be of greater worth to the concern. The stimulus to the ambition of the foremen because of the opportunity so to show their worth is thus lost. Instead of these men being moved by the hearty desire to co-operate with the firm and with each other "for the good of the company," they are usually impelled by feelings of jealousy and impair the efficiency of themselves and the entire organization by their backbiting and faultfinding.

And yet with any method of organization there must be a head and a strong one. A "cheap" superintendent is dear at any price. A strong and capable man in this position is usually worth any reasonable amount necessary to secure or retain him. A large manufacturer once said "My $20,000 superintendent is the cheapest man I have." In reply to the expected "Why?" he said: "He's my 'dividend maker.' I tried 'em at $3,000, $5,000, $10,000, only to keep on losing. Finally, I made up my mind I wouldn't pay less than $20,000—got my man, and he's bringing my dividends. Cheap at $20,000."

The Foremen.—The most important men in the shop. You may have the best qualified superintendent, but if you have inefficient foremen, you have poor management; you may have the best machinery—but with inefficient foremen, poor results; the best systems—complication; the best desires toward your workmen—your poor foremen bring upon you labor troubles galore.

When one stops to consider that these are the men who come into daily touch with your workmen—that they practically control the shop life and shop destinies of your men on machines and bench—that to them falls the responsibility of getting the best results from the workmen, and upon their knowledge you must depend when it comes to the question of getting the proper and best results from the machinery you have bought—is it not absolutely true that they *are* the most important men in the shop, and that their methods, their intelligence, their experience, are questions most vital to you and your business?

Usual Methods of Appointment and Development.—And yet what are the facts in many cases? The foreman is very often a former machine hand promoted to this position because of superior

intelligence, diligence, and desire to please. This man, who should have a wide and thorough experience in modern machine practice, is often simply a graduate of your own shop, with experience limited to your routine practice.

The Proper Type.—The foreman should have a thorough knowledge of the best mechanical processes and the types of machines best suited for the work he handles. He should have also a wide knowledge of the tools, such as jigs, milling fixtures, dies, etc., best adapted to his work, and of methods of using them so as to procure the greatest economy in production; and, last but not least, the ability to handle men and get the best from them. Am I setting too high a standard for the foreman? I say No! positively No! These are the men who can "make or break" the concern. As is the foreman, so is the department. In nine cases out of ten, he is your "Sticking Point," or is responsible for it, be it poor workmanship, high costs, tardy production, or trouble with your workmen. This is as true of the small shop as of the large one.

Therefore, select him with care, watch him and help him, educate him, and, above all, give him the stimulus of "his chance" and watch him grow, if he is the right kind.

Modern Tendency.—True it is that in the most modern shops the tendency now is to depend less and less upon the foremen on the important questions of speed of machines, types of tools, setting of standard time, and proper prices on jobs. The best practice in the up-to-date shop is to institute speed bosses, rate-making departments, and tool and tool-designing departments, entirely independent of the foremen. In fact, as will be brought out later, such plans, properly instituted and carried out, will accomplish wonders; but this course is rendered necessary because of the weakness of the ordinary foremen. But in most shops it is hardly possible to consider such elaborate, though extremely valuable, plans amongst the first steps. Depend upon your foremen you must. Even though the greater plan of organization with speed bosses, rate-making departments, etc., may be determined upon, this consideration of the foremen's efficiency is equally necessary. In fact, the broader plan will utterly fail unless it is supported by the intelligent efforts of the heads of departments.

The Management's Representatives.—Never forget that the foremen are the management's direct representatives to the workmen. The men form their opinion of the company from their opinion of their foremen. Their daily life and career are subject to his control, his whims and vagaries; their promotions and increases in pay depend upon his characteristics and knowledge. They more often have

reason to depend upon his practice of favoritism than upon his sense of fairness. The character and ability of the foremen affect the workmen more directly than any other three factors in the shop, organization and management, and as a consequence have a direct effect upon their output and disposition toward the company.

Job Bosses and Workmen.—In any shop organization, however small, the question of the proper division of the working force, so that the proper amount of supervision can be given to each man or group of men, must receive careful attention. A foreman cannot properly oversee his entire department without assistance and still give his attention to the larger and more important details of his work. The usual method of securing this result is to appoint the more efficient members of the working force "job bosses" with some limited degree of authority over a small group of men. These men perform their share of the work, receiving a slight increase in their pay.

The importance of carefully selecting these men is at once apparent. They are usually the next in line for advancement to assistant foremanship. From these men come your heads of departments. And yet how many managers or shop superintendents possess accurate information concerning the character and ability of their job bosses? They usually promptly pass over to the foremen the responsibility for making these selections, and very often they in turn just as promptly pass the coveted position to some favored friend without much regard to the matter of his ability compared to that of the rest of the group affected—or, to drive the thought harder home—without regard to the ability and intelligence of the rest of the *candidates* for promotion. Advancement in wage and authority is as important to the $1.50 per day workman as it is to the superintendent. It is the neglect of just such points as these that cause workmen to feel that merit and hard work count for little, and that extra effort brings no reward in the face of an unfair foreman's selection of his friends and favorites for the only progress that is possible to them.

System of Pay and its Effect Upon Workmen.—Of equal importance in its direct effect upon men is the question of the "system of pay" and the method of handling it. Little will be said at this point regarding these matters. However, in considering the defects directly affecting the workmen and seriously affecting the cost of production in many forms of business, the first prize (for total inefficiency) may usually be given blindly to the pay system without much danger of going amiss.

The average system, usually piece work, started by men little versed in modern methods and based upon data usually secured by the foreman by methods "strictly their own"—and as often totally incorrect—supplies a first-class millstone to burden any concern.

Little faith can usually be placed in the average foreman's estimate of a "fair price" for a job. Lacking proper knowledge himself, he will, however, unhesitatingly and with a great display of confidence, place a price upon any piece of work. Then follows the old story of, first, excessive earnings by workmen; second, dissatisfaction on the part of the employer, and consequent reductions in price; and, third, the invariable result of discontented workmen, who find that their only protection from reductions in price lies in the strict adherence to a certain limited line of rate of earnings. The foremen continue blithely to set the prices, the employer suffers unconsciously through excessive costs and limited output, and the workman works away discontented and determined to even up matters for unfair treatment. These conditions are still very prevalent.

It is astonishing to note the manner in which otherwise sensible men will put into effect and enforce methods and policies vitally affecting the workman's daily life without regard to the "human element" that enters into his makeup and that the manager should know must of necessity be reckoned with.

Much has been said about the tendency of the modern workman to limit his output and not put forth his best efforts to improve either himself or the company's product. This complaint, however, generally comes from the manufacturer who does not consider it worth while to give close attention to such details as are mentioned briefly here. Seldom is it heard from the manager who wisely "puts himself in the other fellow's place" and then builds up his plans along lines that he realizes would mean encouragement and inspiration to him were he in that other fellow's place.

Any man who has sufficiently clear vision to recognize such faults existing in his business must make up his mind to start right in at the bottom and build up. No points can be neglected. The faults in organization and methods mentioned in this brief outline, if existing, must be eradicated before any permanent or really effective improvement can result.

Defects of System and Method of Manufacturing.

It is not my intention to do more at this point than to point out the most serious defects of the ordinary systems, as the succeeding papers will deal with the defects and suggested methods of better-

ment quite fully. The need of system is, of course, becoming more widely recognized each year. But in many cases the manufacturer just stops short of full success. Many times he also fails to realize the full purport of his system and to reap the full, and, in fact, the greatest benefit possible from it.

Value of Stock System.—To him the stock system is simply a means of keeping trace of his stock. It may never occur to him that it is possible to develop it easily so that he can cut down his necessary working capital to a minimum and reduce his interest account to the lowest point possible, or that, by a little development and attention on the part of several intelligent men, monthly inventories correct within 1½ and 2 per cent can be easily secured and made the basis for an exceedingly valuable factory profit-and-loss sheet, so that factory conditions can be accurately noted monthly.

Order and Tracing System Functions.—His order and tracing system are often considered "necessary evils," and yet the great success of many a concern depends upon the promptness in filling orders and keeping delivery promises, and the tracing system is responsible for this.

The tracing system as an aid in keeping down stock investment through keeping the regular stock constantly moving is also often a new idea.

Chief Value of a Cost System.—The cost system as a means of ascertaining the cost of the article is often the only thought in the manufacturer's mind when the "cost system" is mentioned, and is accordingly its only function that is developed. In fact, however, the valuable analyses of costs, operation by operation, to be secured from an efficient cost system, supply the manager with invaluable data from which to work in *reducing* costs. Nor does their effectiveness stop here. If it is decided to start a campaign to increase the efficiency of the factory force and to eliminate the inefficient men, then the individual records of the man will be secured from the cost records. In large bodies of workmen, a steady and intelligent campaign along these lines will work wonders.

While to some this last point may appear to be an unnecessary refinement, it must be admitted by all that a cost system must provide a method of cost analysis which will unerringly reveal the points of high and excessive costs throughout every stage of manufacture. The failure to accomplish this means the failure of the chief function of any cost system, namely, ***making possible the greatest economy in manufacture.***

Wage System and its Effect upon Economy of Production.—Linked up closely with the cost system is the "system of pay" or the wage system already touched upon. This will be handled fully later, but must be mentioned now because of its great importance. It, and the "method of organization," form the two pillars upon which rest the whole framework of a successful concern. Any weakness here is felt throughout the entire structure.

Machining Methods.

Closely linked up with the cost system and wage system are the shop processes of production, such as machining, assembling, etc. The lack of system in the first two almost invariably means a deplorable lack of proper results in the shop processes of production. The lack of accurate information relative to the amount of work that can and should be turned out from a first-class tool it astounding. In many shops it is only another case where those methods which vitally affect the cost of production are "up to the foremen," and the foremen, lacking knowledge and experience, cheerfully run their departments year in and year out, satisfied if they turn out sufficient volume to keep the "super" off their trail.

In my own shops before they were reorganized I have seen cases where one department was operating their machinery at such cutting speeds and with such depths of cut as to show a loss of 21 per cent when compared with another department directly beside it but under another foreman. And, at that, both departments were far below the standard of efficiency they have now attained, and the end has not yet been reached.

In this matter understand me clearly. The average foreman wants to do well and make a good showing. But he cannot but lack the desired (and indeed necessary) training and experience to secure proper results. The only proper method of handling these men is to *train them*. It can be done. It has been done with fine results. Necessarily, then, this vital information as to what should be produced from any one machine is usually lacking "in the front office."

I recently installed in certain factories several large boring mills and heavy planers built by two of the highest grades of manufacturers. In order to test the amount of knowledge possessed by the manufacturers of these machines, they were called upon for advice as to the best results that could be secured from them when working under differing conditions. Simple questions were asked as to the speed and depth of cut possible in order to secure the best results. These builders of the tools could not give a definite answer that

would be of any material assistance to any one needing light. They knew that their machine tools ran as fast and "would turn out as much work, etc.," as any in the market, but when it came to the question of shapes of tools, depth of cuts, results upon differing grades of metal, results from the use of water and composition on the tool, etc., they floundered hopelessly. The lack of knowledge of the best results obtainable is not by any means confined to the older type of shops. There is many a factory today which to the eye presents a modern appearance, with its new buildings, well ventilated and cleanly, its fine equipment in machinery and tools, and its show of bustle and hustle, which yet need the "doctor's care" badly.

The shop, whether new or old in appearance, operating under the older methods of obsolete or obsolescent wage and shop systems, hampered by lack of accurate knowledge of best obtainable results in up-to-date processes of production, by lack of progressiveness and lack of "pulling for the good of the company" spirit in the working organization, is far behind in the race for commercial supremacy.

Sales Department Methods.

Thorough and careful consideration of sales-department methods is considered essential in this series. A full study of any business is incomplete if the sales-department methods are neglected. For the "production of orders" is a most essential link to the chain.

The possibilities of scientific development in this branch of the ordinary business are so great that they must be carefully studied. To this statement I often hear the manager say "scientific development of the selling end of the business! Why! a salesman is a salesman. The selling of the goods is an art in itself. A matter of individualism. Salesmen are born, not made. Training of salesmen! Bosh!"

The managers who make such statements are usually of the type that will employ a new salesman, let him "dig around the shop a bit," give him a catalogue and start him out. A mere "taking of orders on price alone," not a finished salesman. For the gulf of difference between a man who takes orders because he quotes lower prices than his competitor, and the salesman who sells the goods at a higher price than his competitor because of his skill and knowledge of his business, is a very wide and deep one. That there is a "psychology of salesmanship" I would be the last one to deny. But innate selling ability, unless backed up by proper knowledge, will not win. Add to natural selling ability a thorough training in the "talking points" of the product, the defects (and good points) of the competitors,

the best methods of meeting arguments and objections, gained from the experience of all of the best men in the selling organization, the most successful means of demonstrating the merits of the goods to the prospective customer—and you have a strong salesman.

Train your men collectively, thoroughly organize them along scientific lines, and then back up your training by simple yet adequate systems whereby you may know that the territories are being completely covered, your prospective customers are being handled properly, profitable prices being secured and competition being met, and you will have an invincible selling organization.

Instead of this condition, one often sees a group of salesmen, jealous and distrustful of each other, lacking in the desire to work together for the good of the company, without a thorough knowledge of the company's goods or their competitors' product, and very chary about sharing what knowledge they do possess either with each other or the poor new-comer. Usually the firm itself is almost entirely responsible for such condition.

The possibilities that lie in the development of proper method are astounding. Actual experience to be described in later articles has proven it beyond the peradventure of a doubt.

Executive Conditions.

The weaknesses outlined in the preceding pages will surely be felt in the executive division whether that consists of one man or twenty. With the possibility of securing only such insufficient data as can be obtained with lack of organization, methods, and systems, such as has been outlined, what can the executive do but struggle along in the dark and in doubt, trusting that his untrained salesmen can sell his product for such a price that a reasonable profit will be shown after his factory, without proper organization, system, and training, has produced it. In passing, let me state again that there is many an executive today who, not realizing the inefficient condition of both branches of the organization, wonders what there is wrong with a business that apparently is in good condition as far as surface conditions are concerned. To such I say analyze the business to the uttermost. Compare it with a modern concern with an organization built upon lines that inspire the workers in it to give their best knowledge and abitity to further its progress, with methods that ensure the best results in cost and volume, and systems that will not only tell the story of progress but also indicate the "Sticking Points"—and then begin to build along proper lines. And when the work is once begun, never let up but fight it out to a finish. It will pay.

THE CHOICE OF MOTIVE POWER FOR THE WORKSHOP.

By R. E. Mathot.

THE COMPARISON BETWEEN STEAM AND INTERNAL-COMBUSTION ENGINES.

Mr. Mathot's article is the first of a short series full of practical suggestion for the owner of the small or medium-sized power plant. The author is one of the best-known specialists in his subject, a high authority on both sides of the Atlantic. He discusses the selection of the "prime mover" for the shop or factory on sound, common-sense principles, and makes his argument clear by concrete examples. The paper now presented deals chiefly with considerations of first cost and initial installation. The next will take up working conditions and running expenses, and the third will give concise but sufficient data of a large number of successful plants.—THE EDITORS.

DURING the last few years the construction of gas motors of all sizes has undergone a rapid extension. Their use for industrial purposes has entered upon a thoroughly practical stage. They have been tested practically by "many men of many minds." We are thus in possession at the present time of exact data concerning them, and of the elements for a close comparison between their service conditions and those of engines driven by steam.

The question of the advantages and disadvantages of these two systems of motive-power has been thoroughly discussed by many authors, and, notably, Prof. A. Witz, of the Free Faculty of Sciences at Lille, brought out in the year 1902 a very clear and very well-supported discussion of the entire subject. The conclusions of M. Witz's investigation were as follows:

> "The thermal efficiency of the gas producer is slightly superior to that of the boiler. The efficiency of the gas motor is far greater than that of the steam engine.
>
> "Considering the two as thermal machines, having for their object the production of work by the transformation of heat, the surest and most rational base for comparison is the ratio of transformation of calories into kilogrammetres; from this point of view we must recognize that the steam engine has been placed in check by the gas motor.
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> "These conclusions are wholly technical. We are setting aside, provisionally, commercial considerations such as those relating to the price of the combustible, the working conditions, the elasticity and reliability of the apparatus, and special advantages which either might offer for special cases."

In the comparative investigation undertaken by M. Witz the gas producers were of the pressure type. Up to that time, in fact, the

larger part of the motive-power installations operated by internal-combustion motors had been served by pressure producers. In the various trials which had then been made in which the suction producer was used, it had given only mediocre results or else had been confined to small units. Since then, however, the builders of suction producers have made marked progress and have succeeded in the installation of apparatus of several hundred horse power, operating with perfect regularity.

The consumption of combustible in a pressure producer is about 20 per cent larger than in the producer of suction type; the use of the latter apparatus, therefore, strengthens M. Witz's conclusions concerning the thermal efficiency of the motor-producer group as compared with the boiler-engine combination. But if these conclusions have thus been established as an axiom, to which the most devoted partisans of the steam engine must yield, it is true that they are not sufficient to confer upon the internal-combustion motor a position of predominance in the domain of the production of motive-power.

Indeed, so far as this question of predominance is concerned, I can not do better than quote again a dictum of M. Witz in the preface which he kindly prepared for my book, "Manuel Pratique des Moteurs à Gaz et Gazogènes":

> "The small motor of the past, operating with city gas, has become the rival of the steam engine. It has won, in fierce fight, the right to live side by side with its competitor. Some engineers predict that gas will oust steam from the industrial field; this is an illusion. For of the two rivals each possesses its own special and peculiar advantages, and both will always continue to find clients."

This paragraph sums up perfectly the situation between the two competitors in the production of motive-power—the internal-combustion motor and the steam engine—and presents, in the easy and graceful style which characterizes the works of the learned professor, the complex problem of determining the choice between the two systems.

It means that in spite of its very recent evolution, the internal-combustion motor can vie with the two-centuries-old steam engine in the development of motive-power under normal and, above all, economical conditions. It answers, therefore, triumphantly, all the unjust criticisms which the partisans of the "steam-engine or nothing" school have launched against the gas motor. On the other hand, it puts a brake upon the enthusiasm of the gas-engine advocates by showing them that lean gas is not the infallible panacea; that, though it may have incontestable good qualities, it is far from

displacing steam; and that each of the two systems has its proper place in industrial applications, according to the circumstances, the results to be attained, and the relative importance which one good quality may have over another in the particular instance under consideration.

The great campaign for the introduction of motors operated on producer gas was inaugurated about the year 1900. It is interesting now to recall the first proclamations of the enthusiasts, prophesying the disappearance of the steam engine in short order, so great would be the economy due to the use of producer gas; huge vari-colored posters covered the walls; a flood of advertising repeated the chorus in the periodicals. Everywhere the promise was made to manufacturers of the effective horse-power hour at the cost of one centime. Many were those who were seduced and who decided to install gas motors. The new machines, it must be confessed, did not always answer the expectations of their builders. In some cases mechanical details were badly combined or badly executed. In others, the apparatus was badly installed. Still elsewhere the most necessary precautions were neglected. As a total result, after a few years a very clearly marked reaction against the use of gas motors became manifest. A certain number of them were even replaced by steam engines. The partisans of these latter regained courage, and certain of them, relying upon special instances, did not hesitate to proclaim (a little hastily perhaps) "the failure of producer gas."

Happily for the cause of progress, we have not yet reached that point. But these sudden reversals of public opinion show that it is necessary to examine the question very circumspectly, and that decision upon the choice of a system should not be made until after minute analysis of the particular conditions surrounding each special installation.

The manufacturers of internal-combustion motors were not deceived in their boast as to the economy of this new type of engine. The most searching tests, in fact, have demonstrated in unmistakable fashion that the cost for combustible used under full load may easily fall even lower than one centime per horse-power hour. But low cost of output is not the sole consideration in developing a system of motive-power. Other factors have an interest at least equal, and in many cases even superior.

The manufacturer who must put in a power plant is called upon to solve a problem, so far as choice of system is concerned, which involves the following factors:

1. The total power to be generated.
2. Space requisite for the installation.
3. Consumption of combustible, of water, and of oil.
4. Disposal of waste.
5. Local conditions, restrictions imposed by the neighborhood, legal regulations, requirements, etc.
6. First cost, interest, and sinking fund.
7. Cost of maintenance and upkeep.
8. Reliability, regularity, and elasticity of operation.

Each one of these considerations may have a greater or a less importance in any particular case; it is, therefore, impossible to predicate the general superiority of one system over another; superiority in this sense can not be absolute, but only relative.

Every comparative investigation which has for its purpose the attempt to rate and apportion mechanical apparatus for the majority of cases, must start with the supposition that the machines are placed in parallel as to general conditions and must assume average prices. These very assumptions, however, will introduce errors if it is attempted to apply the results of such study to special instances, in which one must reckon with individual conditions and special determined costs. With these limitations in mind, I propose to take up, point by point, the factors in the problem of power-plant installation listed above, and to study the behavior of the various types of prime mover—stationary steam engines, semi-portable steam engines, turbines, and internal-combustion motors; these last I shall consider under the heads of those operating on illuminating gas and those using producer gas, both from pressure and suction producers, those using oil, and those of the Diesel type. I shall try to present impartially the advantages and disadvantages of each.

1. Total Power to be Generated.

What are the maximum, the minimum, and the average power that the plant will be called upon to furnish? During what time will these various power outputs be demanded? Do variations of load occur suddenly or gradually? Are the periods of maximum load repeated periodically or are they accidental? These are the particular questions which must be taken under consideration in deciding what systems of motive-power to adopt. The wide variety in the actual cases which arise prohibits any general solution, and we must of necessity study the problem by means of concrete examples.

Let us take, for instance, the electric-lighting installation for an isolated plant. It must be in operation six or seven hours daily dur-

ing the winter and two to three hours during the summer. It includes a battery of accumulators to answer the incidental demand for light during the day or after 11 o'clock at night.

Such operating conditions would almost always exclude *a priori* the use of steam engines or of gas producers, and would limit the choice either to a gas engine operating on city gas (if it is available in the locality) or to an oil engine. Manifestly, the two types of apparatus first mentioned would involve an expense for starting them and getting them into operation which would be excessive in proportion to the cost of their normal operation. And under these conditions it becomes advantageous to employ a more expensive combustible, but one which permits instantaneous stopping and starting of the engine. The case outlined is that of an installation operated for electric lighting only. Quite often, in connection with such plant, there may be associated a heating service or one involving some other utlization of motive power. It is clearly understood, of course, that any such supplementary conditions would have an equal claim upon consideration; a question of this kind always requires thorough study if we are to reach the most rational and the most profitable solution.

I was recently consulted concerning a joint installation for heating and electricity for a large establishment consisting of four parallel groups of buildings about 30 metres apart, joined by a central gallery. The total cost of the installation was 75,000 francs. It had been awarded to a heating contractor who had relet the electric installation as a sub-contract. This latter represented 18,000 francs of the total cost. The plant provided to fulfil the requirements was as follows:

Three multi-tubular high-pressure boilers carrying 12 kilogrammes per square centimetre (170 pounds per square inch) and of 30 square metres heating surface.

One high-speed vertical steam engine of 30 horse power.

One dynamo, 18 kilowatts.

One battery of accumulators, 60 elements, 390 ampere hours.

The heating was done on the low-pressure system. A pressure regulator was therefore placed on the steam-heating main, which served also to receive the exhaust steam from the engine. During the winter months the heating system operated almost continuously. The engine was run occasionally, either to furnish the lighting direct, or to charge the accumulator battery. During the summer, on the other hand, no heating was required, but it was necessary to fire one boiler every day or at least every two days in order to run the steam engine.

I did not, in my report as expert, criticise the group arrangement which had been made, but I might point out here some irrationalities which resulted from the desire to combine the heating service with the motive-power plant. The high-pressure boilers were unsuitable for the heating service, because this operated at low pressure. High-pressure steam assuredly was necessary for the engine, but this runs only intermittently and for relatively short periods. It is not provided with a condenser and is uneconomical.

It would have seemed logical to separate the two installations completely, and thus to install on one side a low-pressure heating system, and on the other an electric-lighting system operated either by an economical steam engine, say of the semi-portable type, or by a gas motor.

Again, let us consider the case of a foundry requiring normally 20 to 30 horse power, but with a sudden demand at the time of pouring, which may rise to 50 horse power for a period of two hours.

In this case the necessary motive power might be obtained from a steam engine normally delivering 35 horse power, but easily capable of being pushed up to 50; or it might be obtained from a producer-gas engine of 50 to 55 horse power running the greater part of the time at half load. This latter solution was the one actually adopted. It has given entire satisfaction to the manager of the works.

If it is not always possible to predicate *a priori* what machine will best suit a fixed set of conditions, it is neverless easy, by following the results of experience heretofore acquired, to proceed by a process of elimination and to mark out the power limits within which each type of engine may reasonably and economically be employed. This has been done in the table on the opposite page in which are shown, also, the consumption per horse-power hour both of steam and of combustible which is normal to each motor.

The turbine has been applied to powers lower than the 500 horse shown in the table, and many producer-gas motors developing less than 15 horse power have been installed. I, myself, have had occasion to make trials with one of 4 horse power, which operated perfectly. The purpose of the table has been simply to give, by means of average figures, a general idea of the limits of power within which each type of motor is most often employed.

The gas engine with suction producer has entered very commonly into use in units ranging between 20 and 100 horse power. If we take installations actually made according to the reference lists of the principal builders, the average instance will be found to corre-

spond to a figure between 30 and 35 horse power. Very large motors of this type are running in metallurgical works, where they are operated on blast-furnace gases. Outside these establishments, also, gas engines of 1,000 and even 2,000 horse power have been installed; a notable case is that of the Sociedad de Gasificación Industrial of Madrid, consisting of six Nuremberg engines, two-cylinder, double-action type, of 2,000 horse power each, fed by Duff pressure producers. The producer installation of this plant is shown on the following page.

TABLE OF AVERAGE LIMITS BETWEEN WHICH PRIME MOVERS OF VARIOUS TYPES MAY ADVANTAGEOUSLY BE USED.

Type of Engine or Motor.	Power Limits within which the Type may be Practically Employed.	Normal Consumption per Horse-Power Hour at Full Load. Steam	Fuel
STATIONARY STEAM ENGINES			
Slide-Valve, non-condensing	15 to 50 horse power	37.5 lb.	5.5 lb.
Slide-Valve, condensing	30 to 100 " "	22 "	3.3 "
Corliss or Sulzer, simple, condensing	50 to 200 " "	17.5 "	2.5 "
Idem, compound	80 to 1000 " " and upwards	13 "	1.85 "
SEMI-PORTABLE STEAM ENGINES			
Simple, non-condensing	20 to 50 horse-power	16.5 "	2.4 "
Simple, condensing	40 to 80 " "	13. "	1.9 "
Compound, condensing	60 to 300 " "	9.5 "	1.35 "
Triple-Expansion, condensing with superheat	300 to 500 " "	7.6 "	1.1 "
STEAM TURBINES			
Condensing	500 to 1000 horse power and upwards		
INTERNAL-COMBUSTION MOTORS			
Illuminating Gas	1 to 30 horse-power	17.50 cu. ft. of gas	
Oil	1 to 20 " "	0.75 lb. oil	
Producer gas, suction	15 to 300 " "	0.88 " coal	
Producer gas, pressure	100 to 1000 " " (and over).	1.00 " coal	
Diesel	50 to 500 " "	0.42 " oil	

Note. The limits indicated above of course are not absolute. Many small steam engines with vertical boilers are in use, for example, in units of very few horse-power each.

Industrial establishments of average size, requiring from, say, 300 to 1,000 horse power, have not as yet appeared to appreciate the force of the arguments for the producer-gas engine, and installations between these limits are as yet few. This state of affairs is, in part, however, attributable to purely general considerations. Indeed, to discard old ideas, to throw away equipment which has been satisfactory and which is still good for a long period of operation, to undertake new and large expenditures—these are matters which the industrial manager does not face except with considerable hesitation.

DUFF PRODUCERS, SOCIEDAD DE GAZEFICACION INDUSTRIAL, MADRID.

On the other hand, the objections which have been urged against suction-gas installations for powers below 100 horse assume peculiar importance in the eyes of those who are contemplating much larger installations. They will willingly admit that a shop utilizing 40 to 50 horse power might, without very serious consequences, take the risk of a short circuit in a magneto, of the chance stoppage of a pipe, or of any similar minor accident; but it is a different matter when the situation involves a shop consuming 500 to 600 horse power, for the risk is too dangerous to run and the losses resulting from an inopportune stoppage are too heavy.

In fact, even the builders of gas engines themselves do not appear so far to have very strongly advised the use of these intermediate sizes. It may be that they have not yet fully developed these types; it may be that they have not manufactured them in sufficient numbers to supply them under advantageous conditions; it may be that they are too cautious in offering guarantees to buyers. Unquestionably, many difficulties have been met in the construction of large internal-combustion motors, notably as to the form to be given to the cylinders, to the cylinder heads, and to the pistons to prevent their rupture on account of unequal expansion. But these difficulties are not insurmountable, and many of them have already been met. These, how-

ever, are the various reasons which have prevented the average shop from benefiting by the economy in fuel consumption which incontestably attends the use of producer-gas motors.

From a technical point of view, it would be absurd to assert that engines operating well in units of 10 to 200 horse power, and again in units between 1,000 and 2,000 horse power, with blast-furnace gases or with suction producers, should be good-for-nothing between 200 horse power and 1,000. My own conviction is that every gas-motor installation, of whatever power output, can assure the delivery of the power to which it corresponds, with regularity and with certainty, if it fulfils the following conditions:

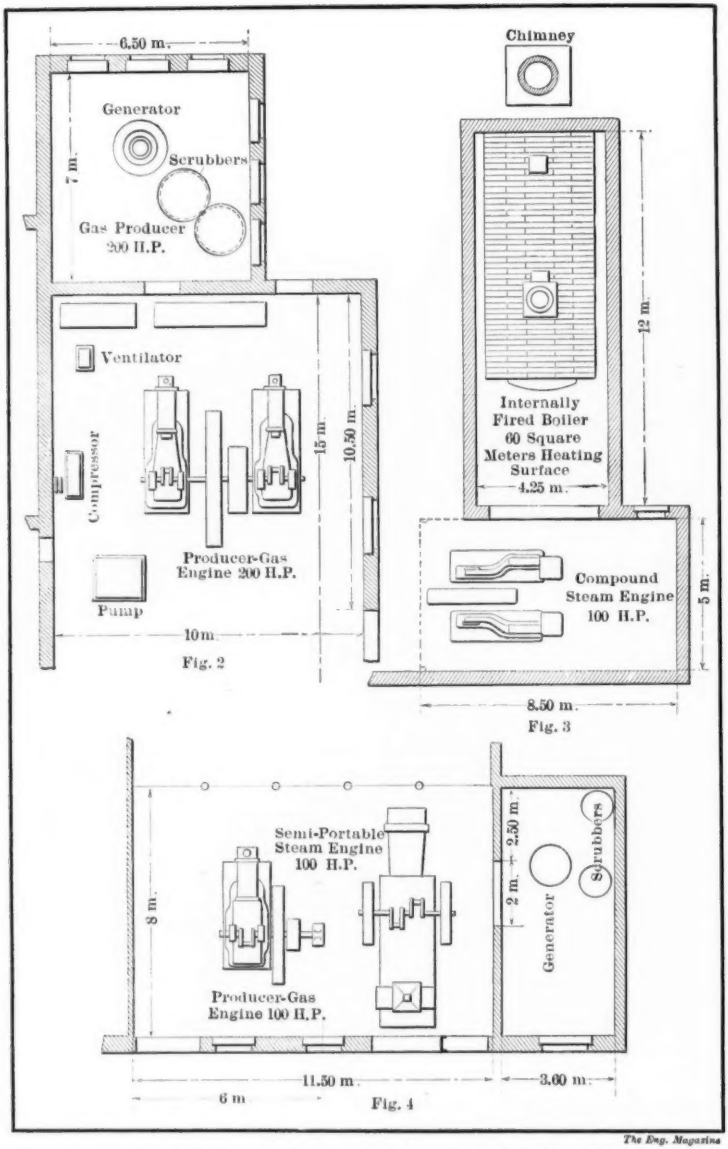
1. Careful and rational construction.

2. A well-studied arrangement of the whole installation, suitable to the local conditions, and directed by an engineer competent in this special field.

3. Careful maintenance and upkeep of every part.

A further consideration which must likewise be faced is that relative to the installation of reserve machinery and to the employment of multiple units. When continuity of operation is a factor of great importance, as, for example, in refrigerating installations, drainage-pumping plants, and some public services, it is indispensable to install spare machinery in order to forestall any possible mischance. If the working conditions involve periodical changes, with important variations in the power demand between the periods, it may be advantageous to install several units which can be operated separately or together, as the service may require. In either case, the solution involves no difficulty, whether the motive power is supplied by steam or by gas. As a matter of fact, in some works of very large extent the use of many separate power units may be a necessity. In recent years, the effort with the steam engine has been to avoid, as far as possible, this sub-division. The steam engine, indeed, is most economical in the largest units. Further, the centralization of boilers, pumps, and auxiliary machinery is conducive to a large reduction in the expense of installation. It is, therefore, generally advantageous under such conditions to generate the whole motive power of the works at a single point and to distribute it either by mechanical or by electrical transmission.

The conditions of the problem change radically with the utilization of gas motors whose efficiency is practically the same for units of 40 or of 300 horse power, and whose operation is much simpler than that of a boiler and steam engine.

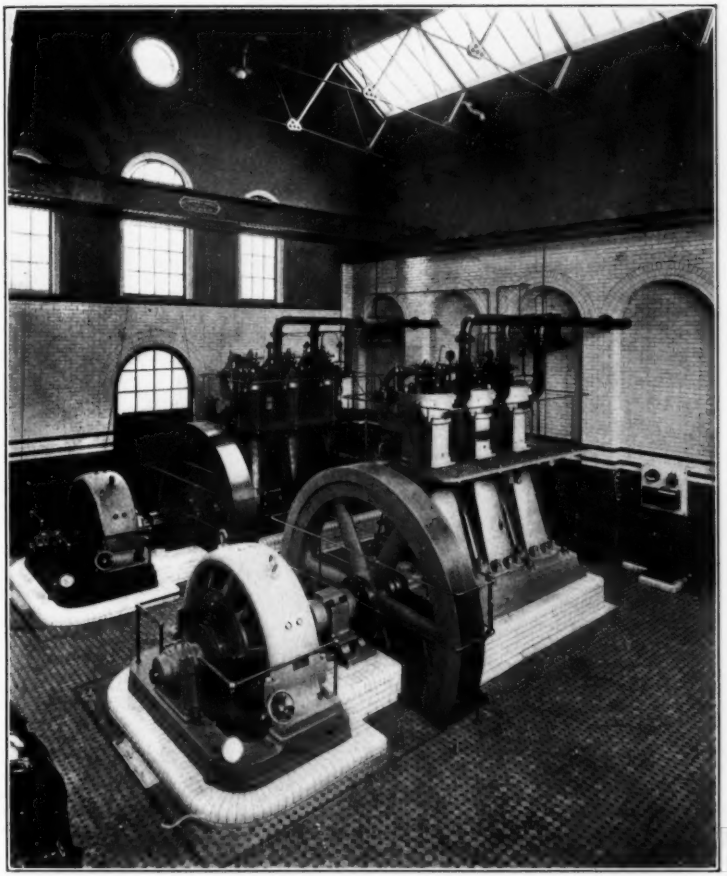


The Eng. Magazine

COMPARATIVE SPACE REQUIREMENTS OF VARIOUS TYPES OF POWER INSTALLATION.

Fig. 2, producer-gas motor, 200 h. p.; Fig. 3, stationary engine and boiler, 100 h. p.; Fig. 4, producer-gas motor 100 h. p. and semi-portable steam engine 100 h. p.

Let us take, for example, an establishment in which ten motors are scattered through various shops, the output of these several units varying from 40 to 150 horse power, all of them operated on gas from a central installation of suction producers. In contrast, let us place a second similar establishment having a single gas engine of 700 horse power with its generator. One might assume *a priori* that the first cost of installation would be lower in the second case than



AN INSTALLATION OF TWO DIESEL MOTORS, OF 240 HORSE POWER.
Built by Carels Frères, Ghent, Belgium.

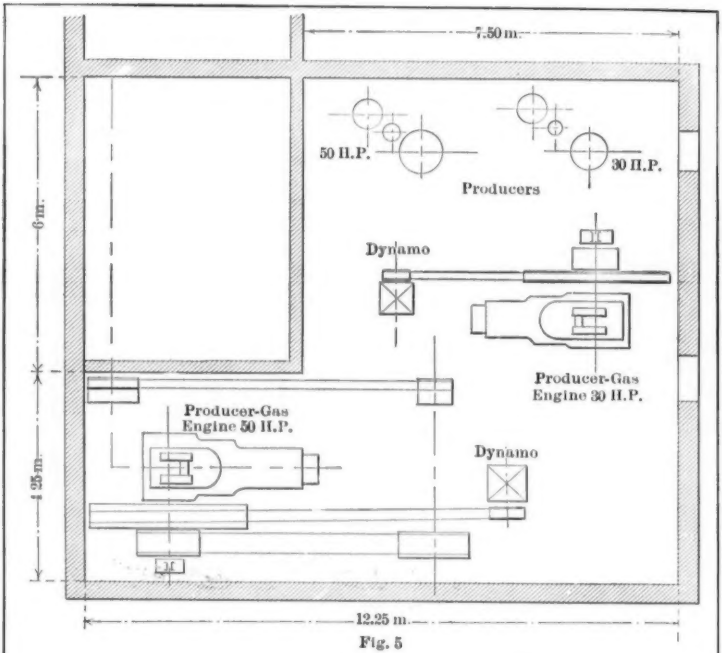
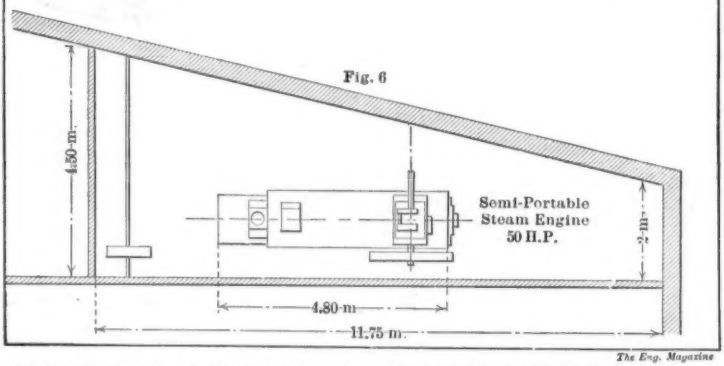


Fig. 5



The Eng. Magazine

COMPARATIVE SPACE REQUIREMENTS OF VARIOUS TYPES OF POWER INSTALLATION.

Fig. 5, two producer-gas motors, 50 and 30 h. p.; Fig 6, semi-portable steam engine, 50 h. p.

in the first, because the initial price per horse power is higher for small motors than for large ones; but as transmission losses would be avoided with the multiple units, their operation would be cheaper than that of the single large unit. The chances of a total shutdown would be absolutely nil, and in many cases the former solution would actually prove the more advantageous.

Space Requisite for the Installation.

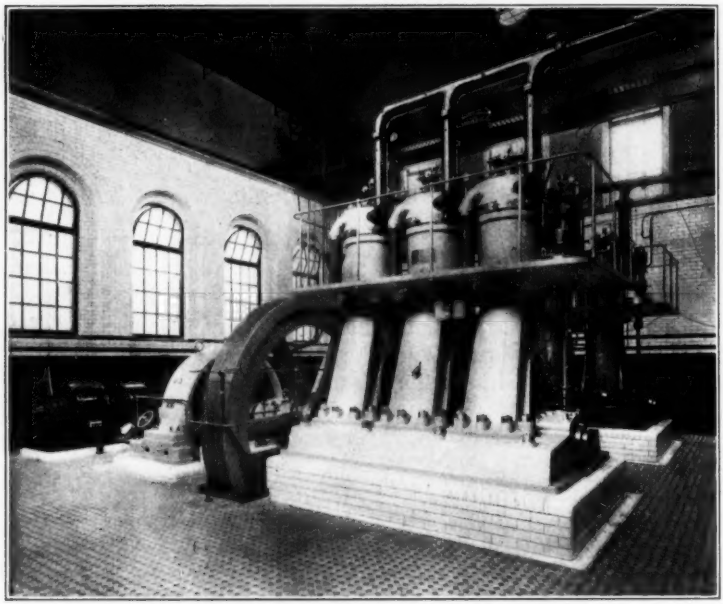
The crowding of the space assigned to the engines is in many cases made a secondary consideration. Generally, of course, and above all when new construction is in question, a sufficient floor area is set aside for the easy installation of machinery, whatever may be its dimensions. Under any circumstances, however, as, for example, in manufacturing plants within the city, or with the replacement of an old engine by a new and more powerful one with no opportunity for change of the transmission arrangements, it may be an important consideration to select a type which occupies the least space possible in proportion to its power.

From this point of view, the group consisting of a boiler, even of the multi-tubular type, and of a stationary steam engine, whether horizontal, vertical or turbine, is almost always that demanding the largest installation area. In this regard this particular combination must be ranked as the least advantageous, especially on account of the space-demands of the boiler. The internal-combustion motor, with suction-gas producer, takes the second place; and, higher still, I should class the semi-portable engine.

By way of illustration, Figures 2 to 6 on pages 502 and 504 reproduce in schematic outline a number of existing installations. The table below sums up the space data of these groups.

Table of Space Occupied by Various Power Groups.

Type of Engine.	Horse Power	Total space occupied by all apparatus and passageways, square metres	Area per horse power, square metres
Producer-gas motor, Figure 2 . . .	200	105 + 45.5 = 150	0.75
Stationary engine and boiler, Figure 3.	100	42 + 51 = 93	0.93
Producer-gas motor, Figure 4 . .	100	48 + 16 = 64	0.64
Semi-portable steam engine,	150	44	0.30
Two producer-gas motors, Figure 5.	50 + 30	52 + 45 = 97	1.20
Semi-portable steam engine, Figure 6.	50	38	0.76



ANOTHER VIEW OF THE 240 HORSE-POWER DIESEL MOTOR SHOWN ON PAGE 503

The type of machine requiring the smallest area for its installation, above all if account is taken at the same time of auxiliary apparatus and of fuel storage, is certainly the Diesel motor.

A motor of 70 horse power, for instance, occupies a space only 3.70 metres by 3.50 metres—say 0.18 square metres per horse power, and it stands only 3.70 metres above the floor at its highest point. The weight and volume of fuel necessary, in proportion to the same elements in the case of a producer-gas motor, are only as 1 to 3, and with the steam engine the corresponding ratio is 1 to 5.

THE VALLEY NEAR THE MINE.

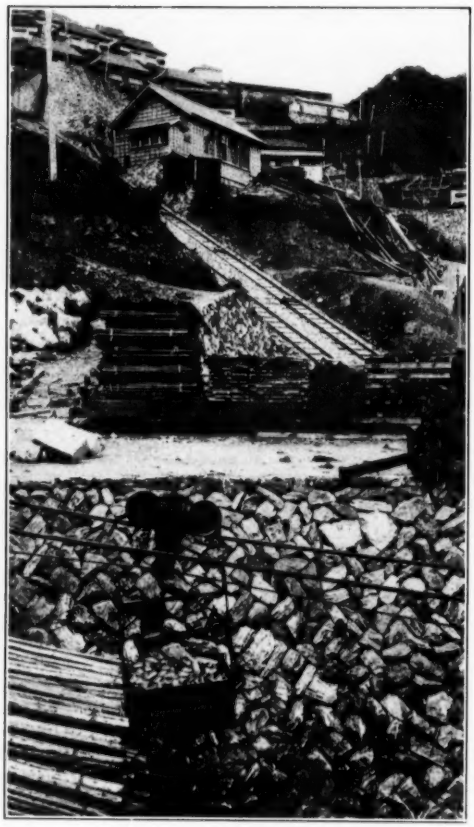
SUMITOMO BESSI; THE GREAT COPPER MINE OF JAPAN.

By O. G. Bennett, Jr.

The present keen interest in the powers and purposes of Japan, in the industrial field as well as others, lends special importance and timeliness to the following description of a distinctive and exclusively native Japan enterprise. The immense works which furnish the subject of Mr. Bennett's article were developed and are operated almost absolutely without any help from Western engineers. The account is the outcome of the author's recent visit to the mines and smelters.—THE EDITORS.

NEAR the center of the beautiful mountain island of Shikoku, and standing rather more than four thousand feet above the waters of the Inland Sea of Japan, there is a peak of sulphide copper ore which has become a center of industry popularly known throughout the Island Empire as Sumitomo Bessi. Here, for centuries before the industrial development of the new world was begun by white men, the Japanese were mining in a crude way and carrying the ore on their backs in small wicker baskets (such as are still used for coaling ships at Nagasaki) down the twelve miles of arduous mountain paths to the smelters on the shore of the Inland Sea.

Today the marvelous little workers are still at the pursuit of burrowing out the mountain, but a vast change has come over the

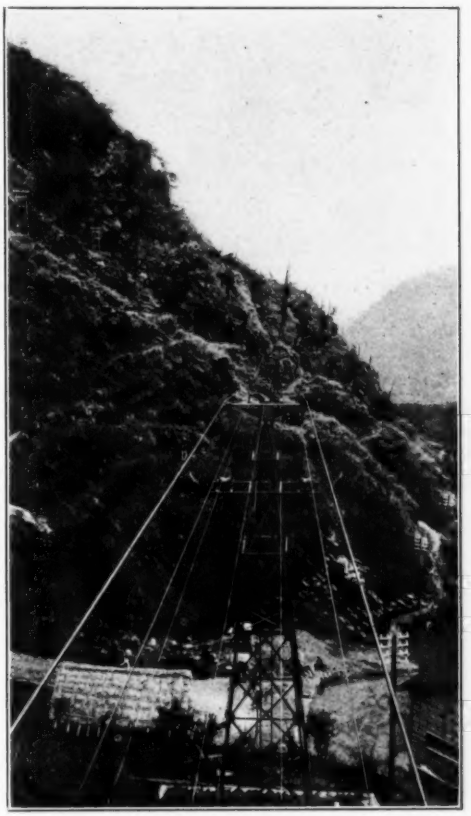


ORE BUCKET ON THE LESSER CABLEWAY BEGINNING THE DESCENT.

methods of working. Where in the ancient times only a paltry few hundred baskets of ore were each day borne over the difficult trails, an output of 9,000 tons daily now glides down a great cableway, and is carried from the foot of the slope by railroad to the sea. In short, there is established at Sumitomo Bessi a modern mining plant, modern in all essential details of engineering construction, and the wonder of the transformation is that it has been wrought without the direct assistance of a single foreign engineer. Neither has the white man any place in the present operation of the mine, and there are certainly no foreigners residing within fifty miles of Bessi. The infrequency of white guests is partly testified by the unalloyed courtesy and hospitality with which one is received, and which inclines one to shame for our abrupt and unceremonious Western manners. The white man is always most welcome in a social way, but his technical advice is neither asked nor needed. Indeed, the amazement manifested by the laborers at my appearance completed the evidence of the infrequency of foreign visitors at the mine. Sumitomo Bessi is a characteristic Japanese enterprise, not only engineered, built, and managed, but owned by Japanese interests solely. Except for the

partial supply of machinery and the marketing of its products, this great industrial enterprise, one of the principal in Japan, is independent of the rest of the civilized world.

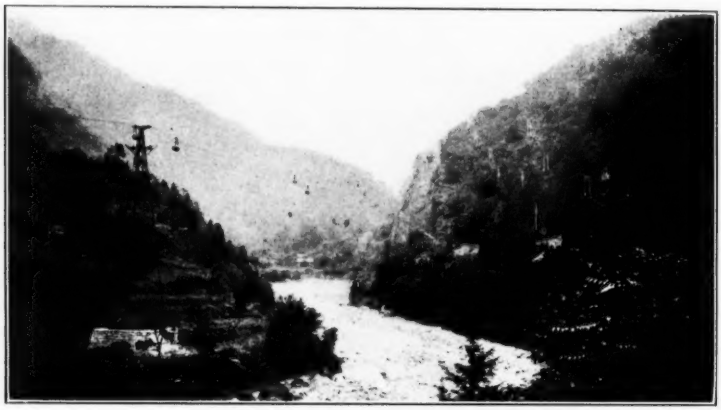
The ore at Bessi is in the form of a rich sulphide, lying in rather thin lodes, which have a slope of about forty degrees toward the North. It so happens that the lode outcrops near the crest of the mountain ridge, and, as the formation of the country is nothing less than alpine, the problem of transportation is the most difficult that the management has had to meet. The manner of the solution of this problem, without incurring overwhelming expense, is the feat that first impresses the visitor.



LOOKING DOWN THE MAIN CABLEWAY, SHOWING DETAIL OF SUPPORTING-TOWER AND THE TUNNEL THROUGH THE MOUNTAIN IN THE DISTANCE.

Between the mine and the sea, transportation is effected by combinations of cableways and steam railways. Going inland, up the valley, there is six miles of railway penetrating as far as possible into the rugged fastnesses. At a point high up on the mountain, several thousand feet above the termination of the lower railway, but actually hardly more than a mile distant, there begins a second railroad which ascends the culminating ridge and winds around the peak to the mine shaft. The supplies and machinery for the construction

of this upper section of roadway were taken up the mountain in ox-carts with almost incredible labor. The gap between the two railway sections is bridged by a cableway which would command much interest but for another and greater one that overshadows it.



MAIN CABLEWAY CROSSING A GORGE. MAIN TRANSMISSION LINE ON THE RIGHT.

About three years ago it was found that the transportation system just described was insufficient for the increasing output of ore, and a new system was built, to supplement the old, from the terminus of the lower railway to the mine. Since the establishment of the new system one properly describes a visit to Bessi as "going up into the mine," which is a remarkable reversal of customary procedure. A tunnel, more than a mile in length, has been driven horizontally straight into the mountain, meeting the main shaft 2,000 feet below the surface. Thus the most expeditious way is to enter the shaft at the foot and go up into the mine. Most of the ore is now lowered from the several levels to the foot of the shaft and taken out through the tunnel. From the mouth of the tunnel there is still an interval of two miles, which is bridged by the greater cableway before noted. The construction of this cableway is remarkable, even to those well acquainted with large engineering feats. There are two heavy steel cables supported on steel towers, the descending line being 1½ inches in diameter, the ascending 1¼ inches in diameter. A third running cable carries the conveyors up and down, or rather affords a retarding influence, for the weight of the descending ore is a source of tremendous excess energy, which is absorbed at the upper end by an

elaborate hydraulic friction brake through which the running cable passes. The valley in which this cableway lies is a marvelous combination of the ruggedness and softer beauty which is characteristic of interior Japan. Dense and brilliantly colored foliage abounds, but the topography is nevertheless so rugged that some of the spans of the cableway are well up toward a half a mile in length, while in one place a long tunnel has been driven to permit its passage through a projecting spur of the mountain; a construction device certainly very novel, if not exactly unique, in the history of engineering.

The climb up the mountain trail, which with devious turns and twists follows the general direction of the cableway, is an experience never to be forgotten. The photographs give but inadequate expression to the beauty of the Japanese landscape, which here grows ever more wonderful as the winding way is ascended. Turning to material things there is evidence on every side of the work of these resourceful and industrious little men. Straight up the mountain runs the high-tension transmission line carrying power to the mine. It is substantially built in the most approved modern fashion, with double poles and cross arms to withstand the fierce storms which

SECTION OF UPPER RAILWAY NEAR THE MAIN SHAFT; UNDER CONSTRUCTION.

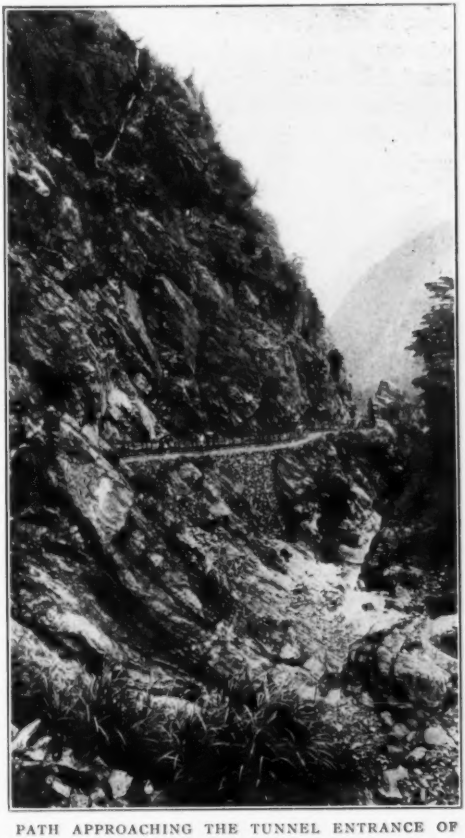
occasionally sweep this country. On the other hand is observed a flume for carrying the drainage water from the mine. High over all this is stretched the cable, and its endless chain of slowly moving buckets. In some places the elevation above the trail is so great that the cables are almost invisible to the naked eye, and the buckets themselves appear against the clouds like a procession of flies crawling across a ceiling.

At the tunnel entrance to the mine new evidence of the spirit of progress is encountered, in a fully equipped electric mine railway, which runs through the tunnel to the shaft. The locomotives are American-built and are equipped with 500-volt motors. Otherwise the rolling stock is Japanese in design and manufacture. Again, inside the mine, modern machinery holds sway. Air compressors, induction-motor driven and supplying an immense equipment of drills, are situated at various points in chambers excavated for the purpose out of the solid rock, off the regularly traveled paths. Standing inside it is difficult to conceive that the scene is not laid in one of the great American copper mines, and admiration increases for the pro-

MAIN TRANSMISSION LINE, 11,000 VOLTS. THE STEEP ASCENT IS INDICATED BY THE ZIG-ZAG PATH.

The flume carrying drainage water from the mine is shown directly beneath the transmission line.

ficiency of the self-taught Orientals who planned and executed the work without any extended previous experience, and without direct assistance from the western world. The illusion of a typical occidental mine setting is enhanced by the half light and by the grime on the faces of the workmen, which prevent the discernment of facial types.

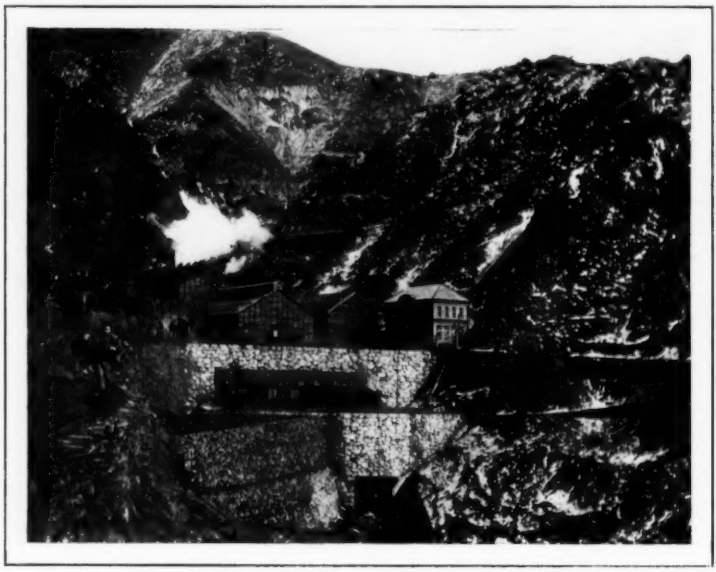


PATH APPROACHING THE TUNNEL ENTRANCE OF THE MINE.

In the organization there is no radical differentiation from operating practice in the western mining world. There is the complete staff of drill runners, miners, helpers, tram men, and the rest. The impression is finally perfected by the constant passage back and forth of electric locomotives, with whirring gears, and the "chug-chug" of innumerable air compressors from far and near. In short, there is nothing of the fabled oriental lassitude about the inside of Sumitomo Bessi. One thing only served to remind me of the oriental nature of my surroundings, and it appeared, too, strangely at odds with the other details. The occasional appearance of mine captains invariably caused their subordinates to bend themselves double in the good old oriental fashion, observed even in the intensely practical and modern surroundings.

It has been noted that Sumitomo Bessi has many electric-driven compressors, and is using rock drills. The bulk of the drilling, how-

ever, is still done by hand; but the apparent disregard of the dictates of modern practice is logically based on the factor of expense, for the hand drillers cost less than 30 cents per day. There may be observed numerous other details, which at first sight tend to indicate lack of enterprise; but investigation always reveals that what appears on the surface to be poor practice, is only the rational result of exceedingly cheap labor. In my estimation this very discernment of the real merits of the question concerning the extent to which labor-saving devices shall be adopted bespeaks initiative, well calculated to dispel the popular notion that the Japanese are solely imitators. Certainly one would be inclined to suppose, under the generally accepted belief in Japanese ultra-progressiveness, that the managers of this mine, with their abundance of capital and resources, would introduce a complete equipment of modern machinery without fully weighing the comparative cost of operation.



SHAFT HOUSE AND BUILDINGS AT THE HEAD OF THE MAIN SHAFT OF SUMITOMO BESSI.

The method of mining is the familiar drifting and stoping, modified of course, by the fact that the ore can always be slid down instead of hauled up to the surface; it is only a question of time, however,

before new works will carry the mine below the level of the discharging tunnel, when conventional methods will be adopted. The concentrating and crushing plant is located at the mouth of the tunnel, where the ore is received direct from the tramway. The crushing equipment is of Blake manufacture. From the crushers, belt conveyors carry the ore to points from which it is drawn directly into buckets of the cableway. The entire system of concentrators, crushers, and conveyors is motor driven.

NEAR THE TUNNEL ENTRANCE, ON THE MAIN PATH, SHOWING THE DRAINAGE FLUME AND COOLIES CARRYING FUEL AND SUPPLIES TO THE MINE.

In the evening, after having been fairly saturated all day in this grimy, modern mine atmosphere, I ate supper with my hosts in the ancient oriental way, seated on the floor, dressed in a kimona and manipulating chop sticks (with varying success). Needless to say, it was difficult to accept with equanimity the complete and utter transition, but I was soon put at my ease by the natural and unostentatious hospitality of my hosts.

In view of the obviously great consumption of power, a keen curiosity as to the source thereof was certainly pardonable. The town on the shore of the Inland Sea, some ten miles distant from the mine, where all the mine supplies are landed and where the ore is shipped is Niihama, which being translated is "Newport." Here, where ample condensing water is available, there has been erected a plant containing two large condensing, direct-connected generator sets, both supplying 3-phase, 30-cycle current at 11,000 volts. Besides, there is one small unit of 90-kilowatts capacity and 3,500-volts pressure. Supplementing this steam-driven equipment there is, in the

mountains, near the mine, a Pelton water-wheel set. The transmission lines are the acme of stability and sound construction, and altogether the power supply and transmission layout is as fine a high-tension system as can be conceived. In connection with the Pelton set there was observed an interesting institution. The acid nature of the water has put out of commission all the automatic governing devices thus far tried, and in place thereof sits a stolid little Jap carefully adjusting the gate opening according to the load. It is safe to say, under the peculiar economic conditions, that the cheapness and efficiency of this form of governor is beyond dispute.

PASSENGER TRANSPORTATION FROM THE LOWER TO THE UPPER RAILWAY.

The hand of the all-powerful and paternal government was apparent everywhere, and it was especially noticeable from an engineering point of view. Under the voltage standards laid down by law, certain precautions against accident are demanded where a voltage of over 350 is used, that being the divisional point between low-pressure and high-pressure practice, as is 500 or 600 volts with us. The lower limit of strictly high-voltage practice is 3,500 volts. Hence this rating for the small generator in the power plant and of the Pelton wheel set was devised. At the time I was unable to discover the reason for the adoption of these unusual pressure standards, en-

tirely out of keeping with the rest of the world. This illogical discrepancy is certain to be a source of ever recurring difficulty as the industrial development of Japan progresses.

There may be seen, in the pictures showing the pathway up the mountain to the mine entrance, a wooden flume, which bears evidence again of the close surveillance of the government. Through this flume, which is about four square feet in section, the strongly acid drainage water from the mine is carried ten miles to the sea, to prevent its discharge into the rice fields at the foot of the mountain, which are kept flooded from early Spring until Autumn by the entire flow of the mountain streams diverted by irrigation channels. Formerly the drainage of the mine was turned directly into these streams, so that it ultimately had a bad effect on the rice crops in the adjacent lowlands. At the first manifestation of this injury, the ever watchful government stepped in and placed its veto on the arrangement. The mine management was then compelled, at great expense, to build a system, ten miles in length, of flumes and tunnels leading direct to the sea. The government inspectors keep a close and constant watch of this system and demand the immediate stoppage of the slightest leak, which results in a high maintenance expense to the mine managers. Thus does the government of Tokyo look out for the interests of the common people.

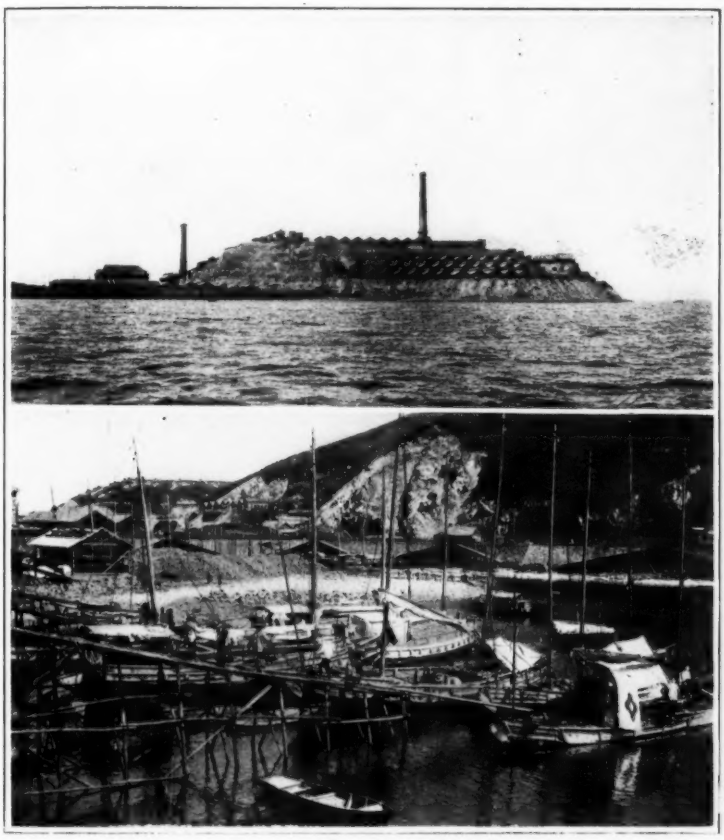
And now we may touch upon the most striking evidence of all, of the close supervision of the government and the way in which it has effected construction and operation at the Bessi mine. As one approaches Niihama, the first thing that attracts attention from a distance is the forest of brick chimneys; the largest a good 200 feet in height, with innumerable smaller ones grouped about it. Except for the lack of smoke the impression is rendered at once of a great modern industrial plant. Closer approach reveals that only one or two of these chimneys seem to be in use, and even these do not emit the white smoke that usually belches from a sulphide-ore refining plant. On going ashore the visitor is struck by the aspect of desertion and neglect that prevails, except at certain points where machine and repair shops are in operation. The great chimney, previously noted, belongs to the generating station for the mine.

Now there arises the question, where is all this immense output of copper ore taken for refining? A glance out to sea will probably reveal a steam tug with a string of strange oriental looking barges in tow, and this gives the clue to the mystery. The ore is towed away in boats to a distant smelter, where the fumes and nauseous odors

can neither injure the crops nor otherwise cause discomfort to the toiling rural population in the district. Regardless of the immense amount of capital invested in this smelting plant at Niihama, the government prohibited its operation and the management was compelled to establish an entirely new smelting and refining base on an island, ten or twelve miles further out at sea, where fumes cannot by the slightest possibility injure the interests of any of the subjects of the Mikado. This dictum of the government cost the Sumitomos several millions, and yet no one who has visited the Butte copper region, with its devastated valleys and blackened hills nearly bare of vegetation, could reasonably contest the wisdom of the Japanese governmental supervision. In its movironment of beautiful gardens and green fields Sumitomo Bessi presents a very marked and agreeable contrast to the copper mines of the Western Hemisphere, and one cannot but feel the foresight of the government in so carefully guarding the welfare of the people and providing against the annihilation of less material things in the onslaught of modern industry. It would seem almost desecration to have the superb scenery of Japan ruined by the spirit of industrialism, as is often the case in our own country.

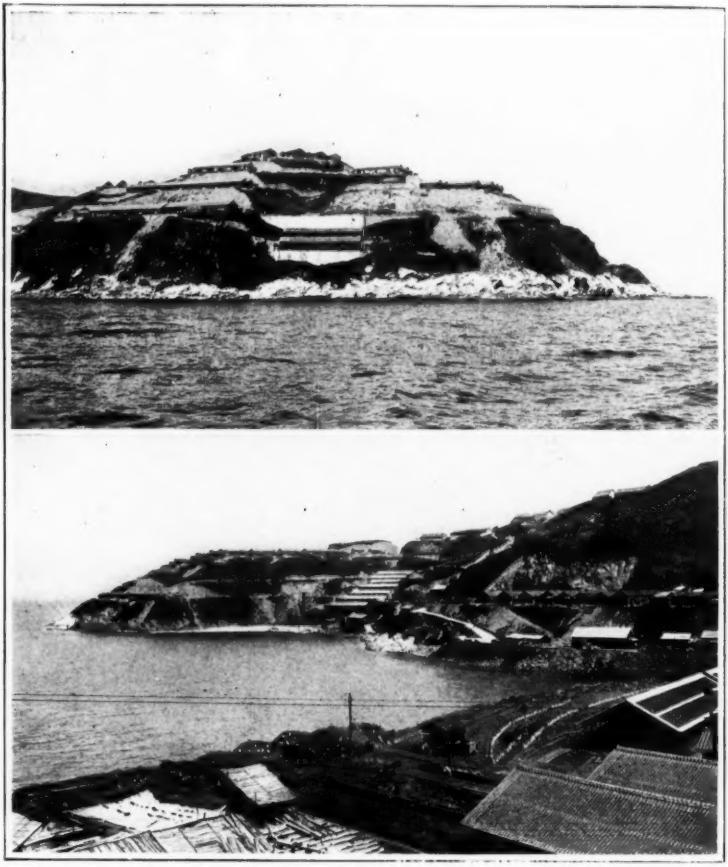
In the description of this great industrial establishment the general survey has been completed excepting the smelting plant, which is a remarkable institution in the eyes of the unfamiliar foreigner, although it is accepted as commonplace by the Japanese connected with Sumitomo Bessi. The island on which the smelters are located is composed of two rocky and precipitous mounds, one considerably larger than the other, the two connected by a narrow neck of land, so that they resemble in the distance a grotesque, thin waisted war-ship half out of water. The larger of the islands is reserved for the homes of the workmen, the company's native hotel, and houses of the officers of the staff. The other mound is completely covered, from shore to shore, over its entire surface, with the ovens, furnaces and auxiliary machinery of the smelting plant. Night and day, year in and year out, this island is a busy hive of ultra-modern industry, and yet it is probably not visited by a white man more than once in the course of a whole year. Could there be a more convincing commentary on the reliance, energy, and intelligence of the people who operate the property?

The metallurgical process, which is called the "Mabuki method" is in some details peculiar to Japan, and is therefore deserving of special description. The ore, on arriving at the smelter in the queer looking ore boats, is first hoisted into bins by a small steam-driven



THE SMELTING PLANT. THE LOWER VIEW SHOWS ORE BOATS UNLOADING.

mine hoist. From the bins it is delivered to the stalls for roasting; each stall being charged with crushed ore and about 10 per cent of wood. The whole charge is carefully clayed over. Then ensues the roasting, which requires about 30 days and results in reduction of sulphur from 36½ to 7½ per cent. The roasted ore is then charged into water-jacketed furnaces—which, by the way, are of Japanese construction. The charge is completed with about 15 per cent flux (pebbles) and 17 per cent coke. Air at about 18 centimetres pressure is supplied by standard blowers, 250 cubic feet of free air being delivered per square foot of tuyere area. All the furnaces are con-



THE RESIDENTIAL DISTRICT AT THE SMELTING PLANT.
The company's hotel is in the center of the lower picture.

nected in batteries to the main flues by horizontal downtakes. The flues are provided with discharge gates for dust, which is tapped off three times a day and contains about 4 per cent of copper. This dust is compressed into bricks by hand and dried over special ovens, the heat for which is supplied by masses of red-hot slag taken from the furnaces. The device results in a notable saving of fuel.

The matte (running about 30 per cent copper and 22 per cent sulphur) is run into moulds and afterwards broken by hand and

charged in stalls for roasting again. Only 6 per cent of fuel is added for this calcining process, which requires about three weeks and results in reduction of sulphur from 22 per cent to 10 per cent. Next the roasted matte is mixed with 10 per cent of coke and charged into round, water-jacketed furnaces. From these furnaces the matte, containing 75 per cent copper and 20 per cent sulphur, is run into reverberatory furnaces. On the surface of the metal in these furnaces there is played an air blast having 8 pounds pressure, heat being derived from coal in the ordinary way. The copper from these furnaces runs about 99 per cent pure, while the skimming contains 30 per cent copper. Skimmings are charged back direct into the round furnaces, while the copper is passed on to another set of reverberatory refining furnaces where the finished product, about 99.8 per cent pure, is reduced and run into wire bars.

A portion of the product of Sumitomo Bessi is used at home, but foreign shipments to all parts of the world are very large. The proportion of the product shipped abroad is steadily increasing, and it is probable that in the future, the world will look to Japan for much of its supply of raw copper. The export product goes mostly to Great Britain, and the users of electrical machinery of British manufacture would doubtless be very much surprised if they knew how much of the copper in their machines had been delved from the earth by these industrious natives in the heart of Japan, a country which less than half a century ago played no part in the industrial or political progress of the world.

The details of the ownership and the labor management of this center of copper production are most interesting. The thousands of workmen, together with the engineers and managers, seem in a general way to form one great family and the principal owner is a young Japanese, " Sumitomo " by name and resident in Osaka. Sumitomo is one of the Japanese captains of industry, and his interests include, beside the mine, a great steel plant and many lesser industries. His name is known throughout Japan, as are leaders of industrial progress known in the United States; but there is attached to it no shadow of calumny. Sumitomo is reverenced and respected by the common people, in a way very refreshing to one accustomed to the conditions in the United States. Sumitomo's genius seems to lie in the selection of able assistants, more than in any other of the qualities of leadership. His managers are intelligent, energetic, and otherwise men of fine personality. The manager of Sumitomo Bessi in particular, Mr. Nakata, is a man of rare quality. The first character-

istic that impresses one is his quiet dignity, but it is immediately apparent that this reserve is born of the consciousness of unusual ability, tested and proven in a thousand ways. Under Mr. Nakata are the chief engineer, Mr. Imada; the mechanical engineer, Mr. Hagio; the smelting engineer, Mr. Kajiura, and the electrical engineer, Mr. Nishikawa, all specialists of the highest attainments.

The great army of laborers and their wives and children regard Sumitomo as their chief and benefactor, and there has never been the slightest dissatisfaction with his administration, so that the organization of labor, such as holds in this country, is quite unknown. Most of the people have been born in the environment, and are intrinsically a part of the great mechanism. In fact, Sumitomo Bessi exhibits, in its organization, a solution of the labor problem as near perfect as man can hope to achieve.

Working at the mine alone there are a total of 6,000 laborers and miners, and in addition to this there is the official staff of more than 700. The average wage of these contented laborers is 22 cents per day, United States gold. Again, at the smelter there is a total of about 1,700 people employed at an average wage of 23 cents per day. The visitor may be at first at a loss to account for the satisfaction of the workmen with the seemingly small wages, especially if he has had experience with miners in the United States; but investigation reveals the characteristic state of affairs upon which the satisfaction is built. The company provides for the wants and cares for the welfare of each and every individual in the establishment. Houses that are comfortable, from a Japanese point of view, are afforded the workmen and their families at a nominal rental of about 20 or 25 cents per month. Each house is equipped with a big brick oven for cooking purposes, and each village has its water supply, of which the purity is maintained with scrupulous care. More than all this, there is in each town a hospital of ample size where the sick and injured are given every comfort and care, at the expense of the management. Schools are maintained for the children, and the moral and mental health of adults is provided for in a regular routine of the simple amusements of which the people are fond, mainly athletic sports and boat races. In short, every real need is provided by the employer to make lives of these poor people worth the living. The same can hardly be said of any great mining center in the western world. The result of this judicious administration is a smooth and regular movement of the wheels of labor that enables Bessi to produce her copper at a price that makes export to foreign markets not only practicable but profitable.

ORGANIZATION AND ECONOMY IN THE RAILWAY MACHINE SHOP.

By H. W. Jacobs.

V. ERECTING-SHOP ECONOMIES.

With this article Mr. Jacobs rounds out his discussion of the mechanical and physical problems of reorganizing the railway shop for the maximum of efficiency and economy. The series began in our issue for September last, and the successive numbers have made a practical handbook of money-saving management and practice through improvements of operations, redesign of machines, standardization of tools and parts, centralization of manufacture, and intelligent oversight over supplies and output. We hope soon to supplement this phase of the matter by a demonstration of the more distinctively "human" elements of the case—an argument for "The Square Deal in the Railway Shop."—THE EDITORS.

HIGH-SPEED steels and redesigned machine tools have worked great improvements in machine-shop production. Have all the other departments been improved to keep pace with the machine shop? The blacksmith shop with its Bradley hammers, bolt-headers and bulldozers, and accompanying oil furnaces, has made rapid strides; and the boiler shop with its hydraulic forming press and rivetter, gasoline and oil heaters, and annealing furnace, together with all the pneumatic tools, is well in line; but how about the erecting shop? Here we find little or nothing has been or is being done. True, there is now and then a cylinder boring bar or probably a rotary planer for valve seats, and perhaps a few antiquated air motors; but close scrutiny reveals the fact that the tools in the erecting shop are sadly in need of attention, for the reason perhaps that it has never been thought necessary to give to the men those individual tools which diminish the manual labor and consequently decrease the number of hours and the cost of production.

One great hindrance in erecting shops is a lack of standards. An instance is that of ball joints on dry and steam pipes. With a standard radius for these joints and forms to suit, all steam-pipe and dry-pipe joints could be finished without the annoying delay of making a sheet-iron template for each joint, and steam-pipe rings could be kept in stock with the ball joint finished, requiring only a few minutes work to cut it off for height when one is wanted. The laborious job of grinding a dry pipe into the flue sheet could be eliminated by the use of

forms, and the time reduced from eight or ten hours to one and one-half or two. The same is partially true of the stand-pipe and throttle joints; by having all joints of standard radius, an interchange of parts would be effected in a short time in many cases, avoiding serious delays in engines leaving the shop.

Washout plugs form another case where a standard taper is indispensable, as by bringing all plugs to that standard, interchangeability and greater safety as regards the danger of blowing out are secured.

A standard taper for all engine bolts could be easily arranged, and by maintaining it a great saving of labor could be effected. With all reamers of standard taper, bolts could be turned and fitted to blocks at the lathe and kept in stock finished. The erecting men would then be enabled to have a bolt on hand when they are reaming holes, obviating the necessity for the machine men to go into the erecting shop, to caliper the hole, and to return again to put the bolt into the hole and file it if necessary. The size and length of all boiler studs could be taken and a number given to each size, and they could be kept in stock and handled as easily as spring cotters. It would first be necessary to check over all the boiler taps and have them conform to a given standard. The same standardizing could be carried out in all cab brass work and boiler mountings, cylinder cocks, boiler checks, and relief valves, so that all joints would be of the same radius, and valves of the same size could be interchanged.

Anyone with knowledge of work in the erecting shop can readily see how much it would be of advantage if all spring rigging and driver-brake pins were standardized, numbered, and kept in stock. Why should a machinist earning 33 cents per hour be allowed to spend from twelve to fifteen hours truing up the journals on a tumbling shaft, when a machine can be made to do the work far better in one and one-half hours? Or why should a man be compelled to ream holes by hand in close quarters where an air motor could not be used directly, when a geared device could be made to permit the use of a motor?

A few devices which aid erecting work are:

A bar and mandrel for hanging guides instead of the old method of using a line; a hydraulic piston extractor; an air gun or a cannon for stubborn frame bolts in place of a sledge and a lot of muscle; a suitable air motor for a valve-setting machine. Why have four men pull in a cylinder bushing with a big wrench when one man can do it with an air motor and the gear of a boring bar? Again, if a pneumatic hammer is essential to a boiler maker chipping and caulk-

ing a seam, why is it not as essential to a machinist when chipping a cylinder saddle or filleting a frame for shoes and wedges?

Another need is for a more careful watch over air tools, to see that they are economical as to the use of air or are discarded when unfit for use. In the condition in which they are kept there are many occasions where it is more economical to drill by hand than to use the air motors. A sufficient quantity of air drills and hammers is the first requisite of an erecting shop and it is important that they be kept in the best working condition.

Another feature is an equipment of hand tools. I have seen a machinist spend forty-five minutes tapping a hole in a boiler sheet with a worn-out tap when it could be done in five minutes with a good tap, and I have seen reamers ruined by having the wrench not fit properly and turn the corners of the square. I have seen, too, seven hours spent in drilling out a bolt when two would have sufficed with a proper equipment of twist drills and sockets, and four hours spent reaming a hole where one-fourth the time was spent waiting for another man to get through with a reamer.

Following are some devices needed in erecting shops:

Stand for setting stack saddle from nozzle base; device for quartering wheels; air device for use when reaming holes vertically; numbered templates for blacksmith and erecting shops, for equalizers and driver brake hangers; jigs for drilling piston glands, back cylinder heads, steam chests and glands, cylinder frames, etc., to afford interchangeability; jigs for compound crossheads to allow guides to be hung standard.

Miscellaneous Economies.—We have followed through the conception of standardized engine parts and its practical application in manufacturing methods in shops, together with the methods of handling the shop work as effected with the plan of standardized repairs. There are numerous minor advantages that may be summarized here, incidental to a thorough working out of good system. We might thus enumerate the branches to which intelligent study of conditions and application of systems should be applied:—

1. The routing of work through the shops.
2. The handling of shop orders.
3. The making, providing, and using of standard blue prints.
4. The establishment of shop sub-stores.
5. The standardization of air-tool equipment.
6. The supervision by a single expert of power plants and appurtenances, steam, electric, air.

7. The classification under individual foremen and by whole shops of the pay-roll, with an analysis of the same.

8. The introduction of a system of reward according to individual effort.

9. The offering of bonuses for saving material.

10. The proper consideration of overcharges, or "surcharges," in comparing shop costs with manufacturer's prices.

Let us take up further examination of these points *seriatim:*

1.—There is often great confusion and unnecessary delay in handling any particular job, or series of jobs, through the different departments of a shop, or even in one department, and there is a general lack of system in placing the work in order of its importance. Two very simple methods of handling and routing work are: First, to have a board sub-divided according to the shops and the individual machines, gangs, smith fires, benches, or men, in the various departments, with tags or pegs representing a particular part having work done on it. From this board a daily sheet may be drawn showing the progress each day through each department, and as the work on each locomotive or shop order is scheduled according to the requirements of the operating department or the store department, the detail elements of the whole job in each case can be provided for like the operation of a regular train schedule or time table. Second, the articles themselves may be provided with tags indicating whence and whither, with days and hours for delivery to and by each repartment. Red or green tags might indicate rush jobs—but these tags should be under the hat of the superintendent of shops and doled out by him for *rush* jobs only.

2.—As the shopping of engines is dependent on the requirements of the operating department and traffic, so the urgency and amount of shop-order manufacturing depends on the requirements of the store department, in so far as that department foresees coming demands or has to fill requisitions from outlying points. The men in charge of shop-order work at the central shops should therefore act in thorough accord with the store department, studying its needs, fulfilling its requirements systematically and promptly. The store department, on the other hand, should furnish its information in specific form and should insist on the requisitions bearing all the necessary information before they leave the division stores keeper's hands. Shop orders, or store-order work, should be confined to the central shops and practically none be permitted at any outlying point, even though in some instances such manufacture might be done just as cheaply

at the small shops as centrally. The reason for this is that there is apt to be a lack of uniformity of standards.

3.—At the time when a railroad decides to standardize its engines it will also be well for it to systematize its mechanical engineer's office thoroughly. The tracings should be reduced to a few standard sizes, three or four sizes in the relation of multiples being sufficient. As it is usual to have margins and a regular form of title for these tracings, it will be advantageous to have the tracing cloth cut up into trimmed sheets and printed with marginal lines and such other indications as appear on each and every drawing. This will save the draughtsman's time in unrolling and cutting off the tracing cloth, will save waste in cloth itself if the standard sizes are made with reference to commercial width of drawing cloth, and the printing will be found to be cheaper than the old hand method. On these tracing sheets drawings of all standard parts will be made, and blueprints sent to the various shops, properly receipted for. These blueprints should preferably be mounted on a heavy pasteboard and shellacked over, and a standard blue-print rack supplied each shop in which to keep them so that the drawing of any part may be quickly located. When this system of standard blue prints is first put into practice, one man should go from shop to shop seeing that it is properly installed and that the blue prints are used by the men on the work and the work done in accordance with them. Thereafter, perhaps once a month, someone from the mechanical engineer's office should make a tour of the road both for inspection and to ascertain the local shop needs.

4.—These sub-stores save a good deal of time and bother. The material in them should be drawn on requisitions in just the same manner as from the general store house, and the requisitions turned over at the end of the day to the regular stores keeper. The foreman of the shop or department, or his clerk, will have charge of the sub-store and an inventory should be taken at least once each week so as to keep the accounts for material straight. I should advocate such sub-stores for small and frequently used material only. The articles kept by these sub-stores should of course be carried in the stock account of the regular stores department.

5.—In two articles appearing in this Magazine in December, 1904, and February, 1905, on railroad-shop tool rooms,* this standardization of air-tool equipment was explained. To recapitulate briefly, three or four types of air motors and air hammers are selected as

* Systematization and Tool-Room Practice in a Railway Repair Shop, by R. Emerson.

standard and such extra parts as may be required are either purchased from the manufacturer or made and kept in the central manufacturing tool room. Any expensive air-tool repairs are made in this central tool room, the motors or hammers being shipped in by express, duplicates having been sent out to the local shops to take their place immediately on notice of their being out of commission. In this way the small outlying points will always have a sufficiency of air-tool equipment in good order, and the repairs of this class of tools, on which the depreciation is very high, owing to the extremely hard service to which they are of necessity almost always subjected, will be reduced to a low figure.

In order to have pneumatic tools operate in a satisfactory manner, a sufficient supply of dry air must be maintained at proper pressure, and to do this considerable care is required in locating the intakes of the air compressor, in operating the compressor, and in looking after the non-leakage of the pipes and the cooling of the air before it reaches the machines, with provision for trapping any entrained moisture. Similarly the electric lines, generators, and motors need to be kept up. There is no more elusive yet real waste of power than occurs in a steam line, and these should be very thoroughly and frequently inspected in order to maintain them in efficient condition. Fuel economies in the boiler plant are likewise of importance and should receive a broad, comprehensive study.

7.—It is a very easy matter when once the pay roll of any given shop or division of a railroad is classified according to service rendered, to check up this pay roll daily according to the men who have worked and determine just how much each portion of the work is costing. If this is done, actually but the work of a few minutes each day, it will be readily shown where it will pay to concentrate one's efforts in reducing this kind of expense, and a careful study of the conditions of the group that promises the largest reduction will reveal how such reduction can be effected. Under this kind of system, a reduction in shop operation expense of from 20 to 40 per cent can very easily be made within six months at a cost of less than 10 per cent of the reduction itself. This kind of analysis applied to a $5,000,000 a year pay roll for locomotive repairs will net a very handsome saving.

8.—We shall touch a little later upon the subject of reward for individual effort, but it should be stated that whereas an expense reduction of 20 per cent or over can be attained by intelligent analysis and supervision without reduction in the output, an increased output

with a simultaneous reduction in expense can be attained only by interesting the men financially in co-operating to this end.

9.—Similarly it is very difficult to attain any tangible results in the way of economical use of materials without offering some substantial form of reward for such care.

10.—Under "surcharge" I would refer to an article by Mr. C. J. Morrison in the October, 1906, issue of the *American Engineer and Railroad Journal,* and also the editor's comment in the same issue. Mr. Morrison explains the surcharge problem in detail and gives the following list of the items making up the surcharge account in a modern railway repair shop:

1. Rent:
   - A. Depreciation of buildings—4 per cent per annum.
   - B. Interest on buildings—4 per cent per annum.
   - C. Interest on land—4 per cent per annum.
   - D. Repairs to buildings—material and labor.
   - E. Insurance.
   - F. Taxes.
2. Supervisory and Miscellaneous:
   - A. Superintendence and office.
   - B. Accounting.
   - C. Drawing room.
   - D. Spoiled work.
   - E. Laborers and watchmen.
3. Machinery:
   - A. Depreciation per annum—4 per cent.
   - B. Interest per annum—4 per cent.
   - C. Repairs (labor).
   - D. Repairs (material).
   - E. Replacing small tools.
   - F. High-speed and other steels.
   - G. Supplies.
4. Power, Heat, Light, Water, etc.:
   - A. Depreciation per annum—4 per cent } On buildings.
   - B. Interest per annum—4 per cent. }
   - C. Depreciation per annum—10 per cent. } On machinery.
   - D. Interest per annum—4 per cent. }
   - E. Wages.
   - F. Fuel.
   - G. Repairs.
   - H. Supplies.
   - I. Lamps, coal delivery, etc.

These items expressed as a percentage of the pay-roll, are found to average for a number of shops, as follows:

	Locomotive Department	Car Department	Total
Rent	11.5	8.1	10
Supervision and miscellaneous	13.8	12.0	13
Machinery	26.6	14.4	21
Power	8.1	3.5	6

It is common practice for railways in figuring costs of their manufactured products to consider only the cost of rough material

and the actual cost of labor, adding from 10 to 15 per cent for supervision. When costs are figured in this way the prices obtained are low as compared with prices submitted by manufacturers, and railroad officials congratulate themselves upon a cheap output, while in reality if proper surcharges were considered they would be surprised at the reasonableness of some manufacturers' prices.

Individual Effort Rewarded.

After, and only after, a very clear idea of the manner in which shop betterment is going to be carried on has been formed, and largely put into effect, should any tampering with the wage system of the men take place. The day or hour rate is objectionable because the man is paid for time, and not for output; therefore he seeks to put in as much time as possible with little respect to rendering a valuable equivalent for his wages, and the time he puts in is preferably over-time and over-pay. The straight piece-work system has been devised to overcome this, but has probably been the cause of greater dissatisfaction between employer and employee than even the inefficient day-rate system. Some form of premium or bonus not interfering with the man's regular daily wages, but over and above and in addition to these daily wages, should be devised in order to have a smooth and satisfactory basis for all concerned. Moreover, the premium or bonus should not be for a certain piece or standard operation, but the individual reward should be determined for each individual set of conditions. For instance, for two men running two lathes side by side and each of them turning out the same piece of work, the time or extra money allowed to each man for the performance of this work should be governed by the conditions and capacities of each of the machines and by the rates of pay (presumably a measure of the efficiency) of each man. This, in brief, is the spirit of the system of rewarding labor according to individual effort; it is a system based upon close analysis of the demands, unit-operations, and other conditions governing the performance of each piece of work, and it differs from the usual piece-work or premium method in that guessing is eliminated and actual observation by practical men, checked up by someone expert in figures, is substituted.

The general policy of the thorough carrying out of such a system of motive-power and shop betterment and systematization similar to that outlined in these papers, will have three real and great benefits.

First, that part of the operating expense known as repairs and renewals to locomotives and machinery will be very materially reduced, thus increasing the net earnings on the road.

Second, the motive power will be kept up in better condition and kept out of earning service a shorter length of time, thus increasing the gross earnings and postponing the necessity for investment in additional power.

Third, the shop output will develop a capability of considerable increase, taking care of in a large way and curtailing what would in the normal course of events be future shop extensions. These extensions for the most part would not be necessary; thus additional capital investment will be postponed. Furthermore, it will finally become practicable for the road to build locomotives in its central shops at a low figure.

These results can be guaranteed provided the betterment system is thoroughly carried out; they can be guaranteed because they represent what has been done wholly or in part on roads in our experience.

Education and Publicity.

While machines and methods are the solid framework of production, unless the co-operation, interest, and enthusiasm of the men can be obtained the system is apt to be lifeless. So it may be said that an ability to get close to the men—to gain and hold their confidence—is even more important than method.

To gain the confidence of the men (not so easy in the constant strife and misunderstanding of the labor unions today) the introducer of these methods, or his representative in the shop, should be a practical and well schooled mechanic himself, versed in the failings and ideas of the men of whom he has recently been one, and of a personality commanding, yet carrying with it an enthusiasm that is contagious. The *rôle* of such a man is to get the drift of the attitude of the individuals in the shop, to be able to recognize the leading spirits, and to enlist their active assistance in the work. This is the more requisite if any system of piece work or reward according to individual effort is being introduced along with the improved methods.

In dealing with the men complete frankness is necessary. The men must understand that the methods and objects are not mysterious nor designed for their detriment. Their reward should be commensurate to the hope held out to them, and the leading men especially should be shown consideration in the way of certain favors, such as being permitted to work on a particular machine, which is valued by them more highly than cold cash alone.

To dispel the feeling usually prevalent that the methods are mysterious and ultimately injurious to their interests, it is well in making an improvement of any machine to point out to the operator just what needs are in view, just what time economies are expected, and it should be set before his reason that it is only fair the company should enjoy some return on its investment which makes time reductions and output increases possible. Over against this picture of the company's interest, which will usually appeal to the fair mindedness of a man, there should be set a statement of his own advantages under the new system.

In order to enlist the co-operation of the higher officials, on whose authority alone such systems can be introduced, it has been found most advantageous to secure accurate time records under the old conditions, and under the new ones proposed, with a calculation of the quantity of the production in each case and the monthly or annual savings which may be effected under the changed method.

To urge all of the men and to enliven a universal enthusiasm and ready will among them, lantern-slide views covering different phases of the betterment work, accompanied by a clear and not too technical address, are very effective. They are the more effective if the plain slides from well taken photographs are supplemented and interspersed with moving pictures of active operations in the shop. We illustrate a few portions of films taken with this end in view.

The first, page 531, shows a limited train of the road rushing out of the picture. This picture, while hackneyed in subject, nevertheless serves to inspire a certain patriotism for the road.

Next, page 532, the spectators are led into the shop where they see a large overhead electric crane in the impressive act of lifting a locomotive off her wheels and placing her upon the blocks in the erecting shop. It may be mentioned that the total time consumed in performing this operation was two minutes and forty-five seconds.

Next, on this page, one of the expert and speedy mechanics in the act of planing a large locomotive frame. The motion is realistic and the man's efforts, making every move count to advantage—to the company's advantage in time reduction and to his advantage in increased daily pay—are very effective. Moreover, the publicity given this man causes him to swell with pride, and among the spectators his friends share this feeling, and the others look forward to a time when they also may appear.

Another series, page 534, would illustrate the greater effectiveness of pneumatic rivetting hammers than of the old perspiring hand methods. This series would interest whatever boiler-makers may be present. In order that no department may be neglected it is well to have illustrations also of blacksmith work.

It may be stated that the preparation and carrying through of photographic illustrations of methods on such a large scale is an expensive process, running far up into the hundreds of dollars. But this investment is quite cheap when it is considered that these views are not only shown in one shop, but may be taken from shop to shop, from town to town, instilling interest into shop men, engineers, and all others whose helpfulness is worth anything. Such an instrument of publicity and frank exposition is invaluable in averting organized dissension and distrust on the part of the men. Especially is this true when there is a strike on the

road and the men filling the strikers' places are under uncertainty and trepidation as to their treatment by the company.

The treatment of the human elements in the problem of railway machine-shop management is, however, large enough for a series in itself, and quite too large to be dismissed in a few paragraphs concluding a review which has followed only broad outlines in the administrative policies and mechanical equipment and processes of the shops. With this number, the discussion must be closed for the present. I hope even in this limited scope it has sufficed to show the large opportunity open for the betterment of railway machine-shop operation, and the efficacy of the means available for the reduction of costs and the maintenance of the operative efficiency of the motive power and rolling stock.

The betterment methods detailed in these papers are not untried ideals from an over-theoretical mind; they are for the most part drawn from the practical application and development now in process, of such a broadly conceived plan on one of the largest Western railway systems of the United States, and from them great additional net earnings and improved power conditions have already resulted.

While, however, this economy and increase of efficiency has been accomplished through the agency of these methods, the credit for the accomplishment must be given, as always, not to the mere methods themselves, but to the man who has the temerity to push them through the inherent impedence of practices and mentalities rooted firmly by long usage and establishment. The vice-president in charge of operation of this railroad, Mr. J. W. Kendrick, has had more than the courage of his convictions; he has had the rare quality of infusing into his men an enthusiastic co-operation unequaled in the inauguration of a new order of things.

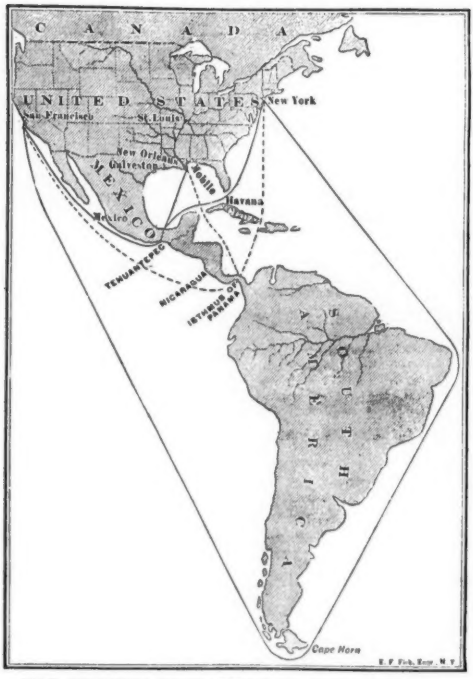
THE TEHUANTEPEC RAILWAY OF MEXICO.

By Gibert Cunningham Terry.

The date set for the opening of the Tehuantepec Railway is a particularly timely one for reviewing its physical aspects and its traffic relations and possibilities. The author of the following article is resident in Mexico, in close touch with engineering affairs and economic movements in that country. The conviction expressed as to the likelihood that the Tehuantepec route will prove a formidable rival to the Panama Railroad, unless most active steps are taken to remodel and reorganize the Isthmian line, was strongly stated also by Mr. John F. Wallace in his testimony before a committee of the United States Senate last spring. The question will turn largely, of course, upon efficiency in terminal arrangements, equipment, and management. It is interesting for the friends of both routes to compare their comparative offerings in these respects at the outset of the new line's opening to public service.—THE EDITORS.

IN or about the year 1518, one Hernán Cortés, Spanish gentleman-of-fortune, made landing, with his followers, in the Mexican city of Vera Cruz. What (and whom!) he did in that beautiful tropical City of the True Cross, and what his achievements were in the other regions of Mexico visited by him, any schoolboy can tell you. Suffice it to say that after he had conquered and looted pretty nearly everything in the then-known Mexico that was worthy of his attention, he began (like that other great conqueror) to sigh for more worlds to subdue. His attention turned itself toward the south and west; to the far south, he was told, there was much gold and other precious treasure and wealth, while beyond the western regions lay the road to the Orient, fabulously rich, unexplored, and full of miraculous promise.

To the south, first, fared Cortés and his buccaneering followers. The harbor of Vera Cruz they knew to be dangerous, for at the time of the great north winds such ships as ventured in were dashed upon the sands and lost. But, sending expeditions down the coast to the south-east of Vera Cruz, Cortés found that on the river Coatzacoalcos there was a beautiful and tranquil harbor, which, while easily entered from the Mexican Gulf, was yet blessed by cool winds and river breezes which bespoke a healthy clime and corresponding lack of the dread *vómito* of yellow fever.



MAP SHOWING COMPARISON OF TEHUANTEPEC, PANAMA, AND MAGELLAN ROUTES.

Therefore, the Spaniards built a small fort at Coatzacoalcos and left a small colony there. Then Cortés, who meanwhile had occupied himself exploring to the westward, laid plans before King Charles V for the making of a wagon road from their colony of Coatzacoalcos over to the Pacific coast, both for the carriage of goods and the ultimate fitting out of a fleet to fare westward to the Oriental countries—on conquering thoughts intent. This plan found favor with the Spanish king, and he not only empowered Cortés to build the *camino real* or "great road," but created him a marquis and gave him immense grants of land, in Mexico.

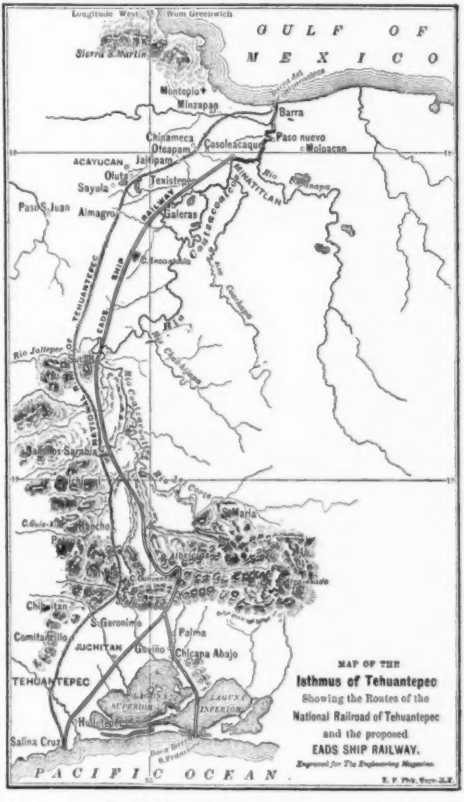
The newly-created marquis was a man of energy and quick action, and he at once began to build his road, utilizing land along the Coatzacoalcos River (which is navigable for over sixty miles) and thence westward toward the Pacific. So was inaugurated the first direct communication ever held between the Eastern and Western Oceans. It was over this same route that the Argonauts travelled, during the great gold rush to California, in the year 1849.

Centuries after the death of Cortés, that great traveller Baron Humboldt went from ocean to ocean over this same trans-isthmian road, and declared that thereon, some day, would rest "the bridge of the world's commerce."

After this, during many decades, little attention was paid to the isthmus region, the whole of what is now "United Mexico" being

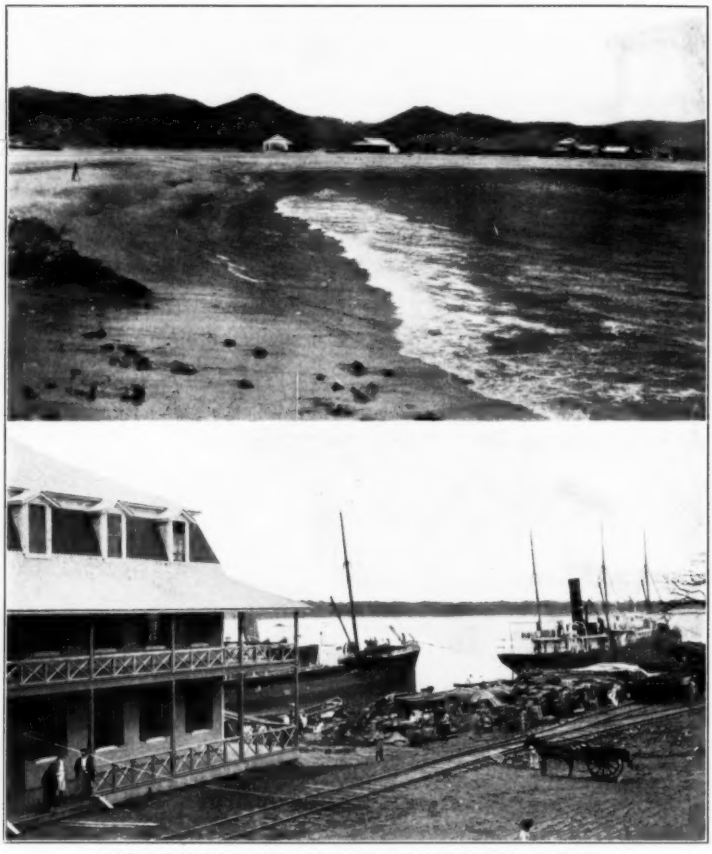
racked by revolutions and internecine strife. It was not until after the American-Mexican war, when General Santa-Ana became dictator, that the isthmian "great road" was again thought of. At that time, a concession was granted to a Mexican to build a railway from Coatzacoalcos over to Salina Cruz, on the Pacific. But the concessionaire was unable to handle the undertaking; his grant lapsed, and the *camino real* remained in statu quo for another half century or so.

When Porfirio Diaz became president of the United States of Mexico, in 1876, the Tehuantepec Railroad was one of the first matters to receive his energetic attention. By him, during an interval lasting from 1878 to 1892, no less than three different charters were issued to as many American and English concerns. All of these failed to make good. Then Eads endeavored to build a ship railroad across the Isthmus of Tehuantepec. His scheme was not feasible, though it received the encouragement and substantial aid of many men of note, among them being Matias Romero, the first Mexican ambassador to the United States. Eads died, a bitterly disappointed man, declaring to the last that one day his project would prove itself to be all that he had claimed for it.



THE TEHUANTEPEC RAILWAY AND THE PROPOSED EADS SHIP RAILWAY.

At last a charter was granted, in 1893, to Stanhope, Hampson and Corthell, under which the concessionaires bound themselves to complete the Tehuan-



THE TERMINAL PORTS OF THE TEHUANTEPEC RAILWAY.
Salina Cruz above; part of Coatzacoalcos below.

tepec Railroad within fifteen months, at a cost to the Mexican Government of $19,181,173.72. However, the road was not ready for traffic until 1895, when the isthmus was finally steel-spanned at its narrowest point (where it measures only 130 miles) by a railroad rising at no one point more than 850 feet above sea level. There was great jubilation, and Mexico solicited the world's freight —at which auspicious moment it was discovered that while the railroad undoubtedly was there, ready to receive and handle any and all freight for Oriental and Occidental ports, a serious handicap existed

in the fact that the railroad's terminal ports at both Coatzacoalcos and Salina Cruz were inferior in all respects, and in fact not even safe. Ships that put in to them ran the risk of foundering on numerous dangerous sand bars; there was no secure anchorage, and only very light-draft vessels could safely make entry. It was soon evident that the isthmus railway was a mere "white elephant" on the hands of the Mexican Government—at least, until the dredging and remodelling of the Salina Chuz and Coatzacoalcos harbors could be effected. And this work, of course, would cost far into the millions.

At this time, agitation was rife in the United States over the question of "Panama versus Nicaragua Canal." Probably for this reason, Mexico considered it useless to treat with the former country with a view to securing monetary and professional help in straightening the isthmus road, and building deep-water ports. However that may be, she went to England, and England responded with alacrity.

Mexico's nominal partner in straightening and generally repairing the Tehuantepec Railroad, and so deepening her terminal harbors that even the greatest battle-ships can dock therein, is that great English contractor, Sir Weetman Pearson.

Under this contract, Pearson and the Mexican Government have entered into a partnership for the operation of the railroad and ports in question, the Englishman taking entire charge of the construction, maintenance, and operation thereof, as agent and representative of Mexico. The whole harbor and railroad work to be completed within a term of seven years from the date of the contract, December 15, 1899. Therefore, the end of the present year (1906) should and will see this important undertaking finally concluded. It has taken some money, to be sure! Since the first work was done on the Tehuantepec route, it is estimated that $70,000,000 has been expended, and it is proposed to spend almost $30,000,000 more in perfecting the railroad and harbor works. This last amount is part of $65,000,000 authorized by the Mexican Government.

While the isthmus is only 130 miles wide at the point where the railroad is built, the road itself has been so surveyed as to measure 192 miles, though at no point does it attain an elevation of more than 850 feet above sea level. It rises quite gradually from Coatzacoalcos on the Gulf coast to the Chivela pass, which is the highest point on the divide, being about 730 feet above sea level. Much heavy constructional work has been called for; in the Malatengo cañon, for example, and in the Chivela pass for about 18 miles, the engineering problems were of a trying nature. At Chivela, it was necessary to

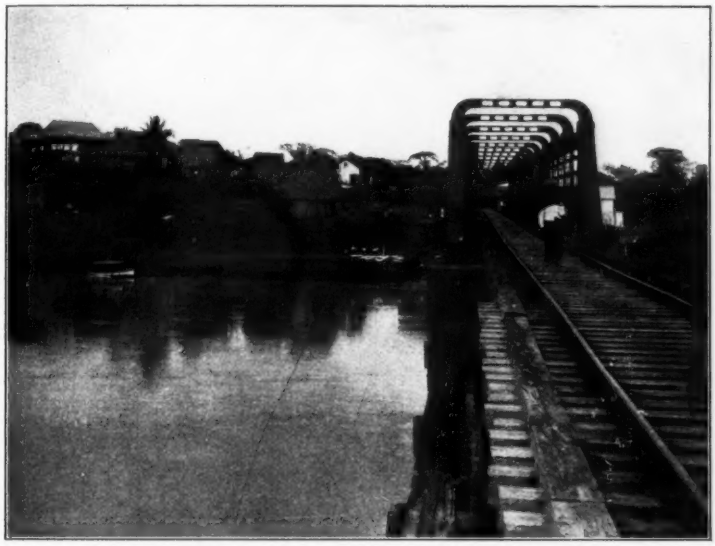
construct two horseshoe curves, and one tunnel. After leaving Chivela, the descent is more or less abrupt, the grade being in places as much as 160 feet to the mile.

This main line is supplemented by a branch of about 15 miles, connecting Julie and San Juan Bautista; at Lucrecia, connection is made with the Vera Cruz & Pacific Ry. (which is now operating trains to Vera Cruz and Cordoba) while Pearson has just secured a concession to build a third line of 15 kilometres extending from the main line to Minatitlan. This latter short line is being built in order to tap the oil-wells which the Pearsons have been sinking during the past two years in the Minatitlan district. Several successful wells have been sunk, and now the oil output is so large as to warrant the erection of a refinery, and the construction of a branch railway to connect the oil field with the outside world. Without selling a drop of this oil, the product will be of the greatest value to the Pearsons, who can then stop buying Texas oil for use on their Tehuantepec road. They were the first people in Mexico to use oil as locomotive-fuel; and while it proved to be highly satisfactory, the cost was excessive. Native oil will therefore be of the greatest advantage.

A RIVER STEAMER, COATZACOALCOS.

At Coatzacoalcos, the river forms a natural harbor of almost unlimited capacity, with an average depth of 50 feet. Therefore the problem which the port engineers had to solve was merely the removal of the bar and means to prevent it from forming anew. The system so successfully employed at the mouth of the Mississippi, and tested anew with equally satisfactory results at Tampico, was put

into practice here, two converging jetties extending from the mouth of the river into the sea so as to confine the current in as narrow limits as possible, and thereby to scour out the channel across the bar. These jetties are over 4,000 feet long, and 1,000 feet apart.



SANTA LUCRECIA BRIDGE ON THE TEHUANTEPEC RAILWAY.

The English company are building quays that extend for almost a mile along the river front, while eight steel wharves and warehouses are being completed, as well as several miles of trackage. All the quays are provided with travelling electric cranes, with a reach from vessel to warehouse or cars of 26.26 metres, while warehouses and cars are equipped with removable roofs which will permit of the handling of freight in a single operation, working the cranes directly between vessels and cars or warehouses.

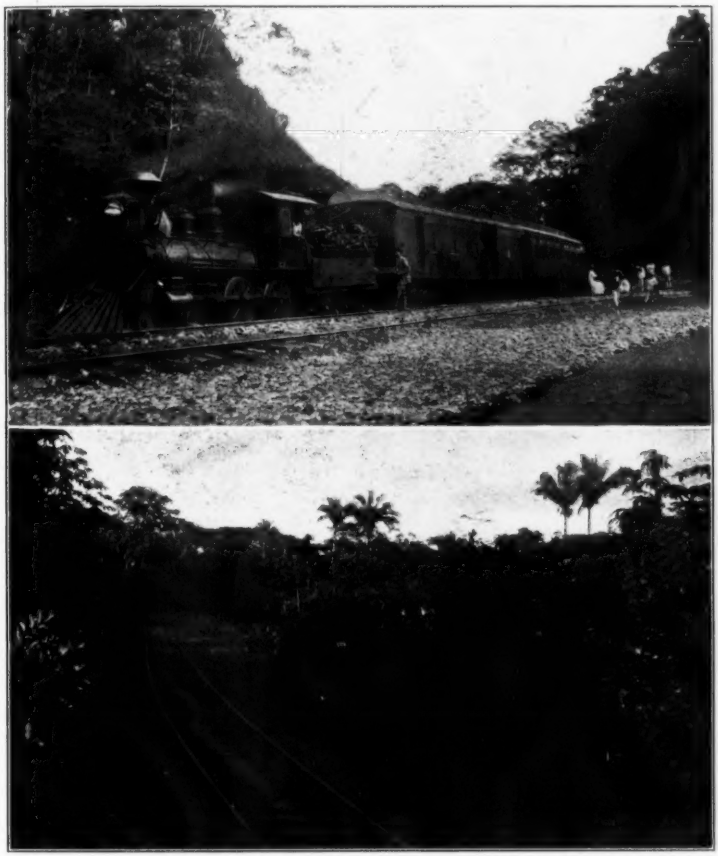
Other notable improvements are under way at Coatzacoalcos—electric-light plants have been installed, model houses erected for company employees, good hospitals equipped, while sanitary conditions, water-works, street-cleaning and so on, receive scrupulous attention. There has, however, never been any great amount of yellow fever or other tropical sickness on the Mexican isthmus; for, while Tehuantepec lies within the tropics, the trade winds that steadily blow in from the Gulf assure coolness and a salubrious climate.

At the beginning of its operations, in December, 1906, the Tehuantepec Railway will have but a single line of track, though a double-track is assured as soon as the freight situation requires it. The rolling-stock at the present time consists of 12,000 freight cars and 50 engines, while supplementary orders for more cars are now being filled. The equipment of the Tehuantepec road is of the most modern description. The gauge is the standard one of 4 feet 8½ inches. Bridges, which are of steel with abutments of solid masonry, are numerous; and as in the instance of that over the Jaltepec River, at Santa Lucrecia, of very considerable size. This bridge is 560 feet long, with five spans, and ties of creosoted pine, native hardwood, and California redwood.

Builders of this tropical railroad have often stated that one of their most difficult problems was avoiding being entirely overrun by the luxuriant vegetation which thrives all along the route, and which, left to itself, would soon cover the entire track and stop the transportation. While the scenery along the road is beautiful beyond all expression, the forests being a great green jungle of palms, huge tree-ferns, and other tropical plants, over which the most exquisite orchids climb, it certainly does not conduce to successful railroading; and the Tehuantepec railway builders have been obliged to sprinkle the entire roadbed with chemicals which kill off all encroaching vines and vegetation, and even dry up their roots.

Probably the most picturesque scenery in Mexico is that through which the line of the Tehuantepec Railway takes its course. Almost the entire run is through dense tropical jungles, where the engine's whistle flushes up flocks of vivid red and green parrots, *guacamaya,* and other *tierra caliente* creatures; from time to time, views are had of the great coffee, rubber, and banana plantations, with their thousands of mixed (very mixed) laborers, there being employed on these plantations Chinese, Japanese, negro and native workmen. Occasionally, the train stops at the "getting-off place" for some of these haciendas, and all along the route you will note the queer, palm-thatched huts of the "hot-country" peon, with their huge shadowing date-palm. They take life very leisurely, these Mexican peons of the hot country; mostly the entire family, in a very small amount of clothing, lounge in utter *dolce far niente* neath the shade of the sheltering palm, careless as to what the morrow may bring forth.

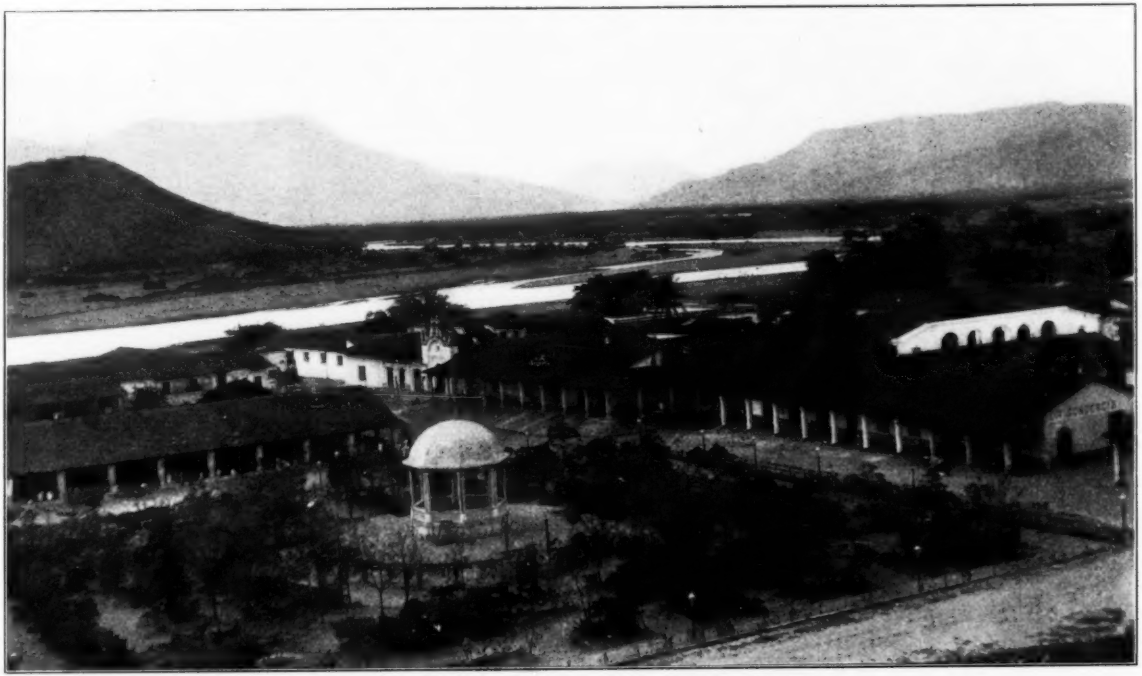
But the show place *par excellence* of the isthmus railway is the quaint, flat, red-tiled town of Tehuantepec, famed mostly for its terrific earthquakes and its stately, handsome women. No visitor who



TYPICAL VIEWS ALONG THE TEHUANTEPEC RAILWAY.
The lower one especially shows the dense tropical growth.

has experienced the one, or seen the other, is apt to forget either of these attributes of Tehuantepec!

At the mid-way station point of Rincon Antonio are located the huge station house, machine shops, and neat, solid cottages for use of the employees. Built in the solid, substantial English fashion, these structures were put up at great expense, and will assuredly not rest under the ban of "flimsy Jerry-built" business.



A GENERAL VIEW OF THE CITY OF TEHUANTEPEC.

The harbor works on the Pacific Coast are perforce on a larger and more expensive scale than is necessary for Coatzacoalcos. There was no natural harbor—nothing but an open roadway, and no river to give a basis for work, as on the Atlantic side. Though the site is well protected with two jutting ranges of hills, a harbor had to be dug. So enormous breakwaters were built far out into the Pacific, and these form the outer harbor, extending over an area of something like twenty acres. The inner harbor has been entirely the result of dredging, and is about 3,000 feet long by 700 feet wide.

A STREET IN TEHUANTEPEC.

The figures in the foreground illustrate the remarkable headdress for which the Tehuantepec women are noted.

It is lined entirely with concrete blocks let down for a great depth into the sand, and giving a secure wall for the building of docks and the anchoring of ships. A great stone wharf has been built, and the inner harbor has been in constant use for several months. Of the six steel wharves and warehouses to be built at Salina Cruz, four have already been finished, and are in use. All the quays are provided with travelling electric cranes, with the necessary reach from vessels to warehouses and cars.

All this great amount of harbor work has been done under great difficulties, for Salina Cruz is a stormy place at times, as Pearson & Company would agree, for during the course of one earthquake and tidal wave they entirely lost their great " Titan " crane, and suffered much other damage.

GROUP IN THE TEHUANTEPEC MARKET.

Meanwhile, the big dry dock—which is to be one of the largest on the Pacific—is progressing rapidly, and will be ready for use in 1907. It is built in the solid rock, dug out by huge drills and the use of the most modern methods. When finished, it will have a length of 630 feet, a width of 70 feet, and a depth of 57 feet; in other words, it will be amply large enough to accommodate any ship that at present plies the Pacific Ocean. In the building of these harbor-works, more than a thousand men are employed, under a weekly pay-roll of about 30,000.00 pesos. These men are of all nationalities, and work together in perfect accord and harmony, under the direction of English and American foremen.

All in all, Salina Cruz ought to be able to handle her share of the world's freight, when the isthmus railway is formally opened on January 1, 1907. The bay at this port is very wide and beautiful, fringed about with typically tropical palm-trees and protected by high foot-hills, and the Mexican Government have invested large sums of money in town improvements, new public buildings, and the like. Water works, electric-light plants, street paving and cleaning, etc., are in active progress, and eventually the Pacific terminus of the Tehuantepec Railway should be a very beautiful and healthful city.

Now that these deep-water harbors are practically completed, the Tehuantepec Railway announce their ability to handle immense quantities of freight between Oriental and Occidental ports, beginning with the first of January. During the past year, one line (that of the Chinese Commercial Steamship Company) has already been making

regular trips to Salina Cruz, bringing not only freight for Mexico and the United States, but great numbers of coolies for use on the isthmus and Southern Mexico plantations, where there is not sufficient native labor to supply the needs.

At the present moment, the Union Iron Works are completing three new steamships for the American-Hawaiian Steamship Company, to be used on the new line which this company propose to establish between New York and Honolulu, in connection with the Tehuantepec Railway. The company has already nine vessels in service between New York and Hawaii, on the Magellan route. Their tonnage varies from 6,000 to 12,000 tons each, and the new boats will be of like capacity. At first, two lines will be opened. One will be a service between Honolulu and New York, while the other will be a coastwise service between Salina Cruz and the Pacific ports of the United States. Two 6,000-ton vessels will be used in the coastwise service between Salina Cruz, San Diego, San Francisco, Seattle, and Vancouver. The six 12,000-ton ships will be used on the Pacific end of the Honolulu-New York line, and the four 8,000-ton boats on the Atlantic end. On their western voyages the ships, which will start from New York, will stop at Philadelphia and New Orleans before reaching Coatzacoalcos; and, after leaving Salina Cruz, will touch at the above-mentioned west-coast ports before reaching Honolulu. On Eastern voyages the ships will sail direct from Honolulu to Salina Cruz, and from Coatzacoalcos direct either to New Orleans or Philadelphia, dependent upon the port to which the cargo is consigned.

Just how great a tonnage of freight the American-Hawaiian Company will give the Tehuantepec Railway cannot be accurately estimated at this time. But as this steamship company has a contract with the sugar planters of Hawaii for moving their sugar crops, the Tehuantepec will certainly get all the sugar which is moved to the refineries in either New Orleans or Philadelphia. Last year the sugar crop of the Islands amounted to 430,000 tons, of which 230,000 tons were refined at San Francisco, 100,000 tons were shipped to Philadelphia via the Magellan route, and 100,000 tons were moved east via the Transcontinental railways. It is estimated that the sugar crop will be even greater this year; and all the sugar which previously has been shipped east by rail from San Francisco, together with that which has gone around the Horn, will be taken to the refineries by the American-Hawaiian line, via the Tehuantepec Railway. This

should give an assured eastern tonnage of at least 200,000 tons. It is a question as to what the western tonnage will amount to; but it is believed that in a short time the westbound movement of freight will be as great as the eastbound, when shippers become acquainted with the low rates to be obtained, and the quick service that will be afforded.

The contract between the American-Hawaiian line and the Tehuantepec Railway is not for any set term of years, but is to run until the Panama Canal is completed, when it can be abrogated by either of the parties. Whether the steamship company will desire to end its connection with the Tehuantepec at that time, and use instead the Canal, will depend upon conditions which will then exist. At the Canal's present rate of progress, however, it will hardly be completed for twelve to fifteen years, therefore it is impossible to conjecture the conditions which will then obtain.

Be that as it may, the average saving in pure distance by the Tehuantepec route over Panama to all points on the Atlantic coast of the United States and Europe is about 1,250 miles. The average freight steamer makes about 10 miles an hour, or say 250 miles per day, thus requiring five days longer via Panama, assuming the time of crossing the two Isthmus points to be the same. It will take a steamer about one day to pass through the Panama Canal, and freight about two days to pass over Tehuantepec from ship to ship, leaving still four days to the advantage of the latter point. The extra cost of the four days to a steamer—say $2,000—plus Canal tolls, would make a 5,000-ton cargo cost about $10,000 via Panama. It is not probable that the cost via Tehuantepec would be much, if any, greater; and there would still be a saving in time of four days, which in the case of quick freight is a desideratum of great importance.

The opening of this railway across the Isthmus of Tehuantepec is destined to be of great importance to the Middle West of the United States, and more especially to the great Mississippi Valley. In his report to the United States Government, Admiral Shufeldt stated that a canal across Nicaragua or Tehuantepec would come to be a natural prolongation of the Mississippi River to the Pacific Ocean; and in the case of Tehuantepec, would bring New Orleans 1,400 nautical miles nearer to San Francisco than a canal via Darien. The distance from the mouth of the Mississippi to the northern terminal of the Tehuantepec Railway is only 810 miles, and the total distance by rail and water from Chicago to the Pacific Ocean by way of the Mexican Isthmus is only 1,875 miles.

AMONG THE COFFEE PLANTATIONS.

Below, growing bananas and coffee; above, the cabins of coffee plantation hands.

First-class passenger rates over the railway will be about four cents Mexican silver per kilometre, or five-eighths of a mile, and the third-class two cents. Eight cents per ton per kilometre will be charged for first-class freight, while the lowest charge for any freight of whatever nature will be three cents. As Mexican money has now the standard of about one-half the value of gold money, rates on the isthmus railway will be very reasonable, besides which, its running cost will be very cheap, most of the labor being Mexican, and native oil instead of foreign coal being burned in the locomotives. Under

THE PRESENT ASPECT OF THE HARBOR OF SALINA CRUZ.
By courtesy of Sir Weetman Pearson.

these conditions, freight via Tehuantepec should be able to take much lower rates than that via the Panama Railway, and will doubtless be able to compete favorably with the Canal route itself, though it is not yet known what Canal toll charges will be. Probably, however, they will be on a par with Suez rates, which are $1.75 per ton of freight carried through the "big ditch."

There will be no troublesome and delaying consular invoices, custom-house inspections, and the like, to delay freight going over the Tehuantepec Railway. In other words, if one ships a carload of (say) cotton from New Orleans to Hong Kong, it will only be necessary so to manifest and bond it; from Coatzacoalcos docks it will be transferred direct to Tehuantepec freight cars, and at Salina Cruz, several hours later, your cotton will be loaded onto the Chinese steamship without an hour's delay for the taking out of consular invoice—that great nuisance in foreign shipping—or inspection by the custom-house. In short, so admirably has been carried out the "straightening and re-ballasting of the Tehuantepec National Railway, and the dredging, deepening and building of her deep-water harbors" (as reads Sir Weetman Pearson's contract with the Mexican Government), that it ought to be able after January first largely to kill the business of that very lame line—the "Panama Railway"—and who knows but what it can yet compete very favorably with the Panama Canal? At least, the Tehuantepec Railway intends to have a "good try."

THE PLANNING AND CONSTRUCTION OF THE POWER PLANT.

V. MAIN AND AUXILIARY MACHINERY.

By A. E. Dixon.

Preceding sections of Mr. Dixon's discussion have covered the location of the plant; the storage of fuel; boilers, grates and chimneys; natural and mechanical draft, and water supply and its purification. His February paper will deal with a matter of increasing interest and importance—gas-producer plant in connection with gas engines as prime movers.—THE EDITORS.

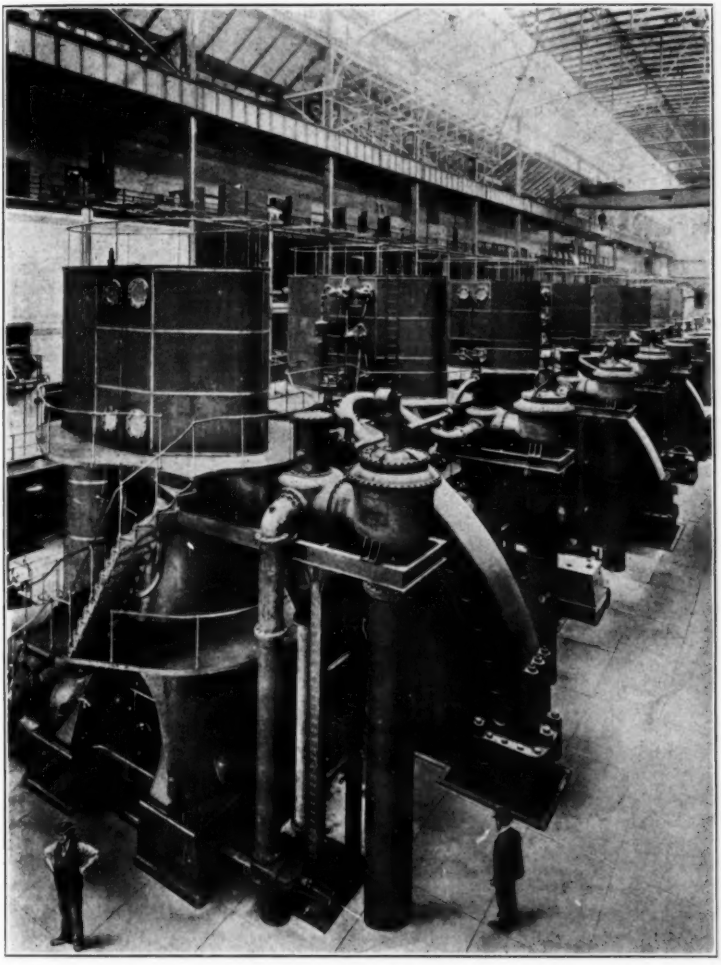
IN settling upon the apparatus to be installed in a power plant first cost is important; so likewise is it important that the continuous operation of the plant be insured by the use of suitable and well designed machinery. There is nothing so nerve-racking as keeping a plant in operation in which the machines required to be "dry-nursed" through the week and then demand the exclusive services of a machine shop on Sunday—unless it may be a street-railroad plant where the machine shop works six days to keep the plant going on Sunday. There are some personal elements which cannot be neglected—for instance, the operating engineer who is convinced that the machine he runs is the best and made by the best people, will get better results than the man who is indifferent; and while it is impossible to value such a spirit, it makes a difference not only in repairs but in operating expenses. A certain amount of intelligence and skill is required in the operation of any machine; the "fool-proof" machine has not yet been devised.

A few years ago, before the advent of the steam turbine, the layout of steam-power plants had become very nearly standardized, when once the capacity of the plant and the size of the units was determined. The appearance of the turbine has produced a great change, not only in plant layout but in many of the details; superheaters, for instance, are being installed in turbine plants in the United States, although they have been used for a number of years in continental Europe in reciprocating-engine plants; high-vacuum condensers were also called for and successfully built. In the United States the temperature of superheated steam is rarely more than 200° F. higher than that due to the pressure, the steam temperature

being in some of the recent plants +581° F., while elsewhere temperatures as high as +750° F. have been used without causing trouble.

The steam turbine, while it is the latest prime mover, will never entirely displace the reciprocating engine, though owing to its lower price per unit with auxilliaries and to its higher rotative speeds, it has pre-eminent advantages in the generation of electrical power, even should it not be able to equal the reciprocating engine in steam economy. The steam engine, however, is not obsolete for electrical purposes and some very large units are under construction at present. Gas and oil engines are by no means new, but for years they were procurable only in comparatively small sizes, and as their makers were not connected with electrical lines there was a great deal of difficulty in introducing them for this purpose; nevertheless a number of gas-driven electrical plants were constructed and operated successfully. The large gas engine is on the market and units of 4,000 kilowatts are now being erected for electrical generation. This line of machinery is almost without exception in the hands of concerns who have had but a cursory interest in electrical lines, and the numerous machines in operation, some driving alternators in parallel, are in most cases found in metallurgical plants. The gas engine has in the past been retarded more through the mis-directed efforts of its friends than by its opponents.

There are two types of steam turbines—the "impulse" and the "reaction"—of each of which there are several makes upon the market. It is extremely doubtful whether there is any difference in the steam economy of these machines when new, and the question of the maintenance of economy cannot be definitely settled at present owing to the short time they have been in use; this likewise applies to the costs of repairs and up-keep; these questions are very important, and it is probably advisable to require the builder to give a guarantee, secured by a suitable bonding corporation, that the cost of repairs will not exceed an agreed-upon figure for a term of years. The available data in regard to the steam consumption of turbines rests almost entirely upon tests made by their builders in the shops without the supervision of disinterested experts; and by reason of the comparative newness of the art, publicity has not been extensively sought. The steam turbine is at present in the same transition stage that the steam engine passed through—in fact, is still passing through in its later stages; but owing to the many advances made in accurate methods, the turbine will pass the early portion of its transition in a

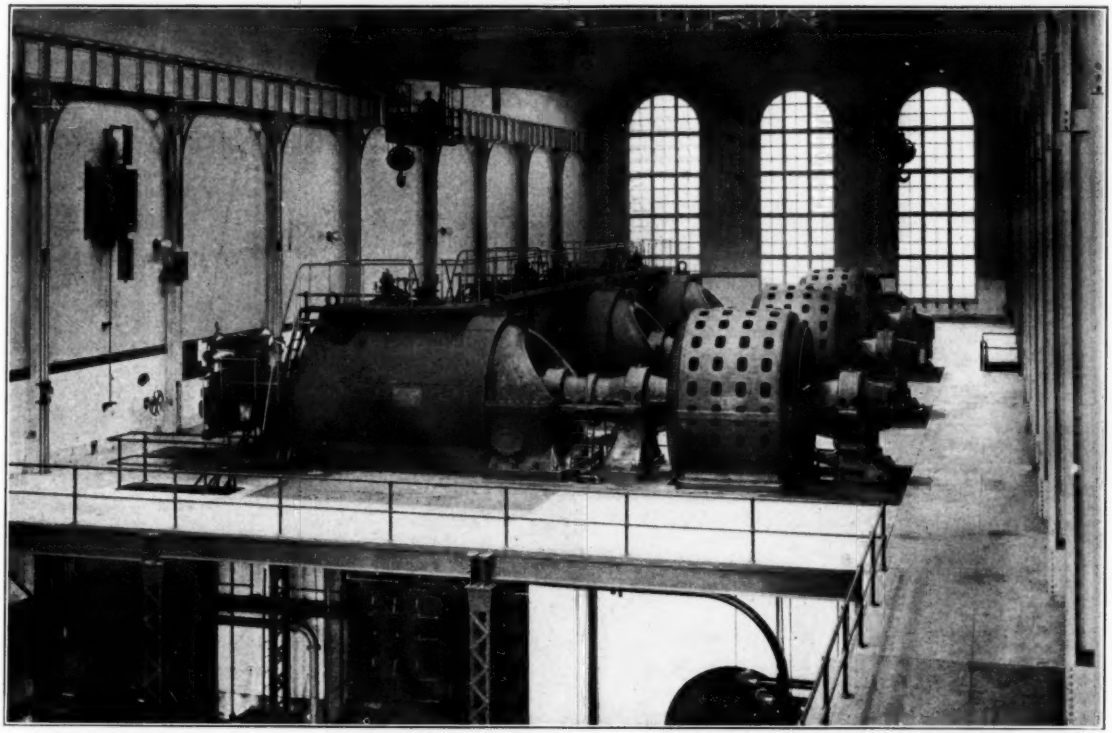


FIVE OF THE NINE 7,500 HORSE-POWER ALLIS-CHALMERS VERTICAL-HORIZONTAL ENGINES, "SUBWAY" POWER HOUSE OF THE INTERBOROUGH RAPID TRANSIT CO., N. Y.

The engines are capable of a maximum of 12,000 horse power. The view is taken from the vertical low-pressure side. Built by the Allis-Chalmers Co.

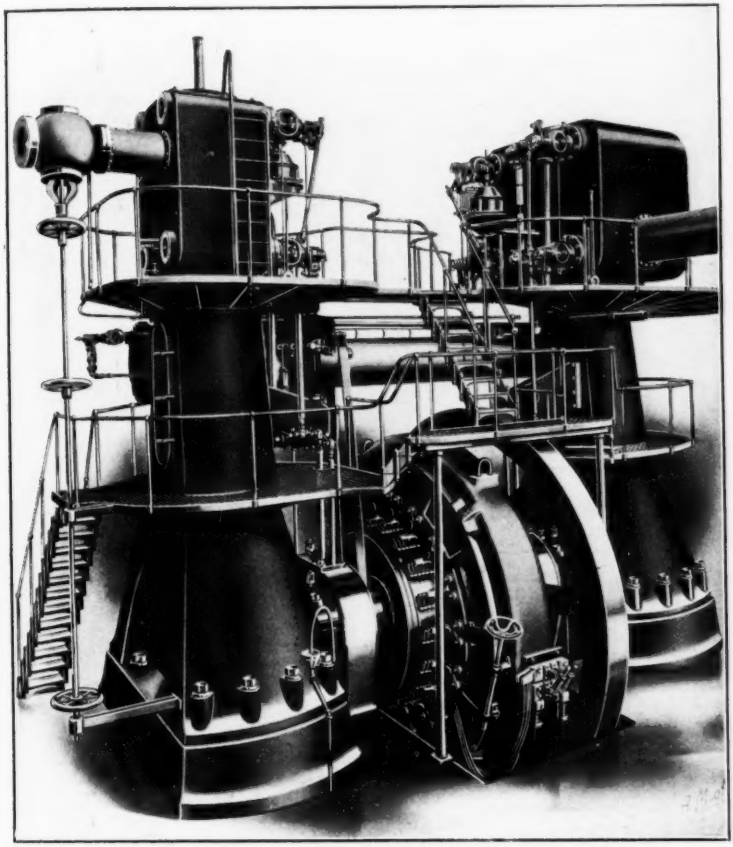
much shorter time than was required by the reciprocating engine to reach a corresponding point of development.

With respect to the position of the axis of the rotor, turbines may be classed as horizontal or vertical; a very large majority of the tur-



ENGINE ROOM OF LONG ISLAND CITY POWER STATION, PENNSYLVANIA, NEW YORK AND LONG ISLAND RAILROAD CO.

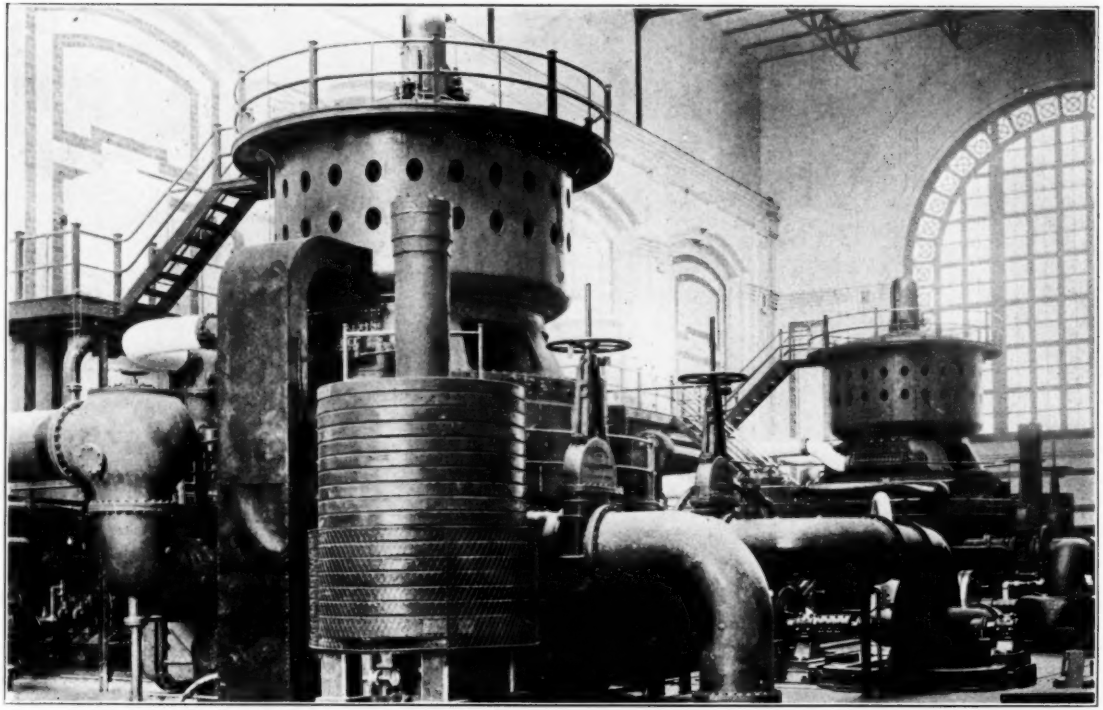
Three 5,500-kilowatt Westinghouse-Parsons turbines, installed. Alberger surface condensing outfit below.
By courtesy of George Gibbs, Chief Engineer E. T.



A RICE & SARGENT VERTICAL CROSS-COMPOUND ENGINE AT THE HAWTHORNE WORKS OF THE WESTERN ELECTRIC CO., CHICAGO, ILL.

Cylinders 32 and 62 by 48 in., 2,700 horse power, 100 revolutions, condensing. Made by Providence Engineering Works.

bine builders favor the horizontal machine, and there are more of that type in actual use. The horizontal turbine can be installed in a low building, and the condenser (should individual condensers be used) can be installed between the piers of the foundation, the condenser auxilliaries being located in the basement; this arrangement is often found in reciprocating engine plants. It is comparatively easy also to open a machine of this type by lifting off the upper portion with the crane; the generator is out of the way and the elec-



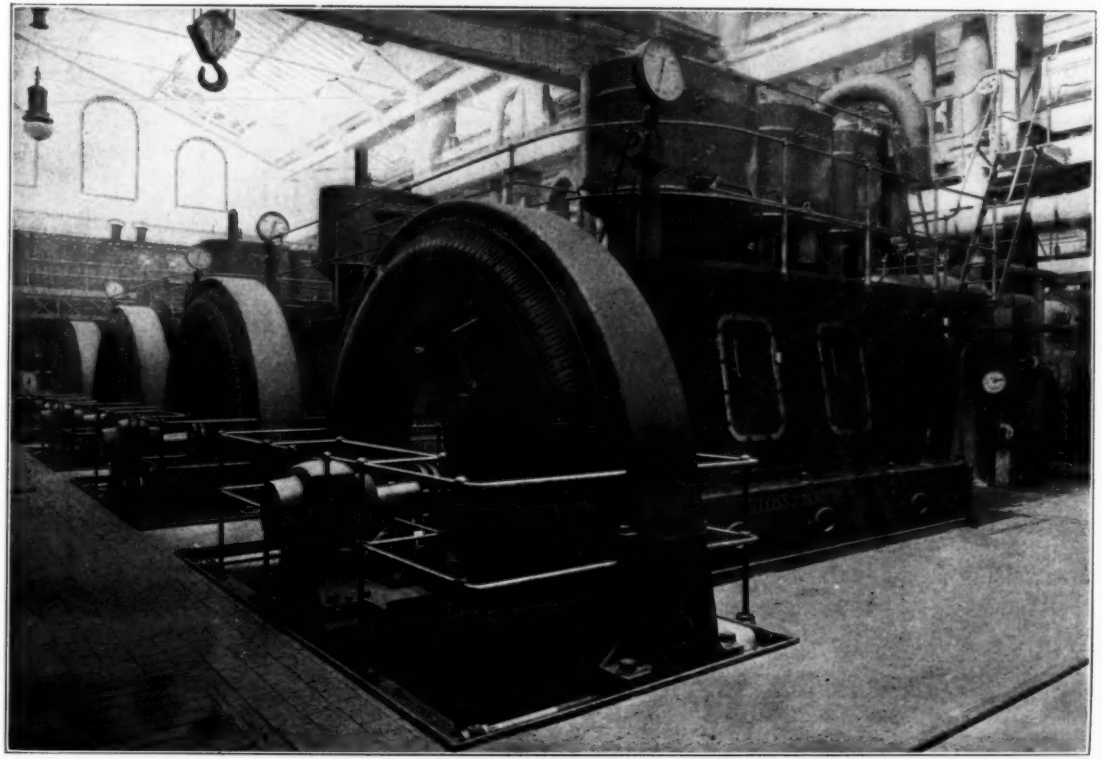
GENERATING ROOM, EDISON ELECTRIC ILLUMINATING CO., BOSTON, MASS.

Shows two of the three 5,500-kw. 6,600-volt Curtis steam turbo-alternators with Worthington condensers built into the base of the turbine installed by the General Electric Co.

trical gang does not interfere with the steam end. In some of the early machines considerable trouble occurred owing to the blades stripping; this trouble was due in part to the fact that the expansion of the casing with regard to the base was not properly allowed for.

The vertical turbine requires considerable height of building, this height being increased where the condenser is built into the base of the machine. Sufficient headroom must be provided to permit of the revolving field being lifted clear of the armature. But this unit is often a compound machine, made up of three superimposed pieces of apparatus, and necessarily takes up but little floor space; it also has the advantage that there are few joints to leak and the steam connection to the condenser is the most direct possible. In some cases the base condenser is not used. One of the disadvantages of the base condenser—in fact, of all condensers which are connected to the unit they serve without the interposition of shut-off valves—arises from the fact that it is impossible to repair the condenser or to put in new tubes without shutting the entire unit down; this is an exceedingly serious drawback in practical operation. The generator is placed on top of the turbine and must be supported by a heavy distance piece in order to give room to get at the shaft glands and to cut down the transmission of heat. Any steam leakage that occurs has a good opportunity to rise and condense on some part of the generator. It is more difficult to remove sections of the casing. The step bearing is occasionally objected to, although there is no more practical difficulty either in the construction or operation of such a bearing than any ordinary shaft bearing, the sole objection arising from the fact that it is a trifle out of the regular run of machine-shop practice.

In one field the steam turbine has no rival; that is in the utilizatipon of the exhaust steam from a constantly or intermittently operated steam engine. In Europe a number of installations have been made whereby, through the intervention of the Rateau steam regenerator, the exhaust from steam hammers, blooming-mill, and mine-hoisting engines, has been utilized and a considerable proportion of the concerns' requirement in the line of electric power derived from what has been previously wasted. The steam regenerator receives and stores up the surplus steam when the engines are operating and gives it out to the turbine when they are not running; a high-pressure by-pass with an automatic reducing valve is provided so the turbine can be operated when the primary plant is shut down for any length of time over the ordinary. A few installations have also

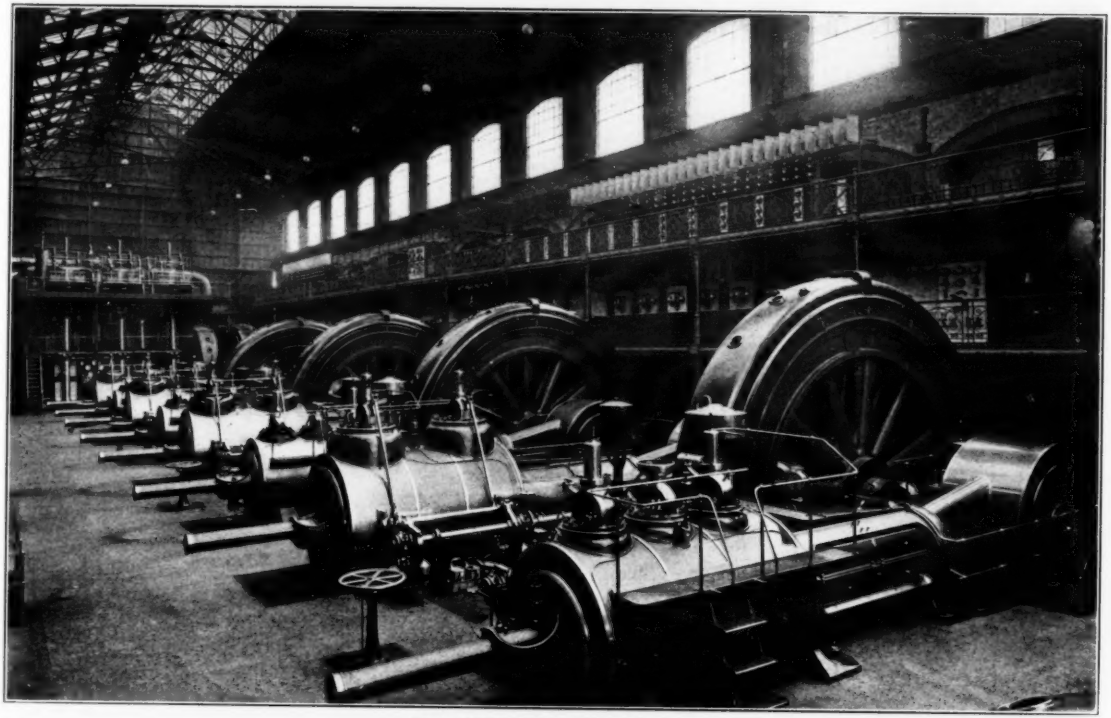


THE ENGINE PLANT OF THE PARK ROYAL STATION. BELLISS & MORCOM, LTD., BIRMINGHAM, ENGLAND.

been made in which the turbines operate on the exhaust from compound non-condensing engines, the two machines being operated together as a compound unit; in this case the turbine is not provided with a governor. In both the above cases the turbines exhaust into a condenser, operating on the difference in pressure between a vacuum and the exhaust of the engines, which normally would be slightly above the atmosphere.

In spite of the advent of the steam turbine, a large number of reciprocating steam engines are being built to drive electrical generators, some of them of large size; and it is not likely that the turbine will ever secure a complete monopoly of this field. For electrical work compound engines are usually employed, as it has not been considered that the advantages in the line of economy gained by triple- or quadruple-expansion engines paid for the added complications introduced; this stand is well taken for the reason that such engines show up to their best advantage only under practically constant loads, and in the electrical generating station the load is very variable. Today a belt-driven dynamo is a rarity, and direct-connected sets are used even in the smallest sizes; hence the speed depends upon that of the engine, and for this reason the generators to be driven by large engines must operate at comparatively low speeds which adds greatly to their cost and to that of the complete unit. Comparatively few engine builders seem to appreciate the value of tail rods as contributing to the satisfactory operation of an engine, and outside of steel plants few stationary engines are equipped with them; they should be used on nearly all engines horizontal or vertical having a cylinder diameter greater than 12 inches, for they contribute greatly to the reduction of trouble in cylinder lubrication and to lessened repairs. In the United States the Corliss-type valve is used almost exclusively in some of its numerous modifications, while in Europe poppet valves are largely used, particularly with machines designed for superheated steam, for which a rotating valve is not suited owing to the large amount of rubbing surface. Steam-jacketed cylinders are used occasionally, but they are somewhat troublesome and unless very carefully handled are liable to be cracked through unequal expansion. It is doubtful whether the economy they secure is sufficient to cover the complications introduced; cylinder condensation can be better prevented by the use of superheated steam.

The superheating of steam is not a new proposition, having been proposed by Mr. George F. Isherwood over fifty years ago for the purpose of preventing cylinder condensation. In the United

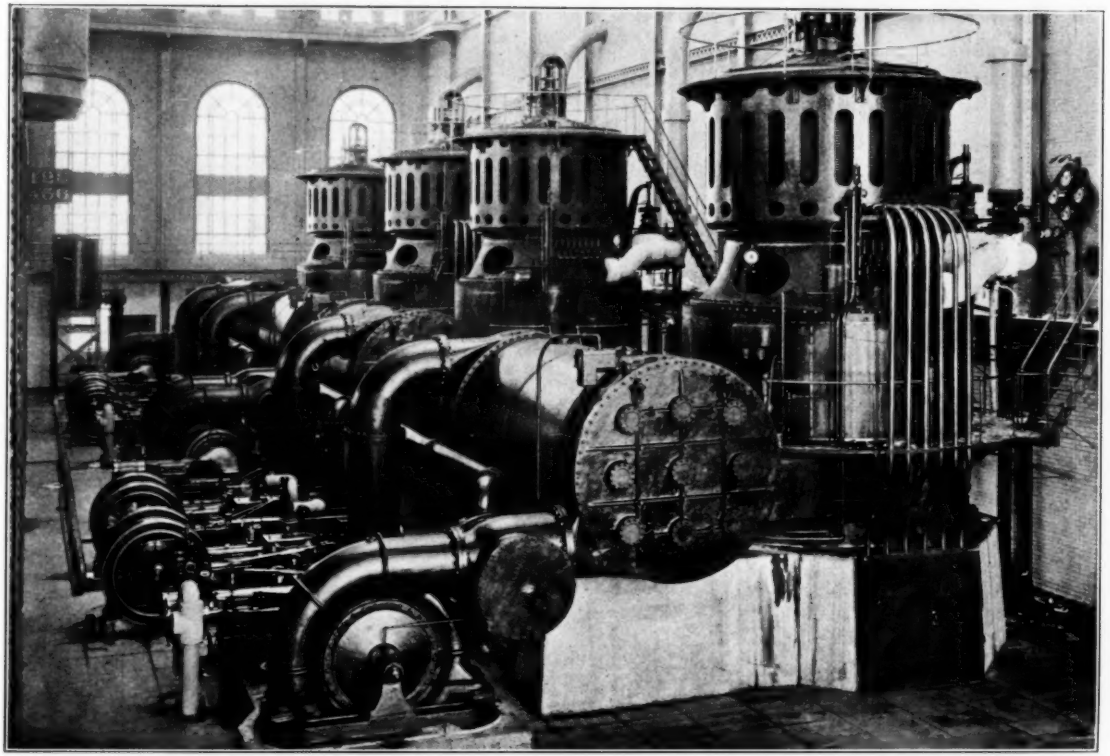


BOW STREET STATION, LONDON.

Four 3,000 horse-power horizontal cross-compound Sulzer engines and two 6,000 horse-power vertical compounds.

TURBINE ROOM AT CHELSEA STATION, LONDON.

Illustration of a modern English turbine station, as the one above is of a reciprocating-engine installation.



GENERATING ROOM, PORT MORRIS POWER HOUSE OF THE NEW YORK CENTRAL RAILROAD ELECTRIFICATION.

Four 5,000-kw. 11,000-volt Curtis steam turbo-generators with Worthington surface condensers, 25,000 sq. ft. surface, maintaining 28-in. vacuum. Installed by the General Electric Co.

States, owing to the comparatively cheap fuel supply, there was but small incentive to the close study of fuel economy until the development of the large power plant; in continental Europe, on the other hand, fuel was expensive and not of the best quality; for these reasons the question of reducing this expense had greater weight and was more closely studied; hence the superheater has reached a higher degree of development there than it has in the United States.

The piping for superheated steam must be well covered, as otherwise the loss of heat is excessive, and in addition the run between the boiler stop valve and the machine should be the shortest and most direct possible. The ideal amount of superheat is that which avoids all condensation losses in the machinery and piping and passes the steam to the condenser as dry saturated steam; under these conditions each piece of apparatus works to its best advantage. Condensation in the cylinder of an engine is a dead loss, and in a turbine also; in the latter there is also a loss due to the water being thrown from the moving to the stationary vanes or nozzles. In the piping for superheated steam there will be no condensation while steam is flowing, and for this reason in some early plants it was considered unnecessary to provide drainage, the fact being overlooked that condensation would occur whenever the pipe was out of use; for this reason it is just as necessary to drain piping for superheated steam as it would be were saturated steam to be used.

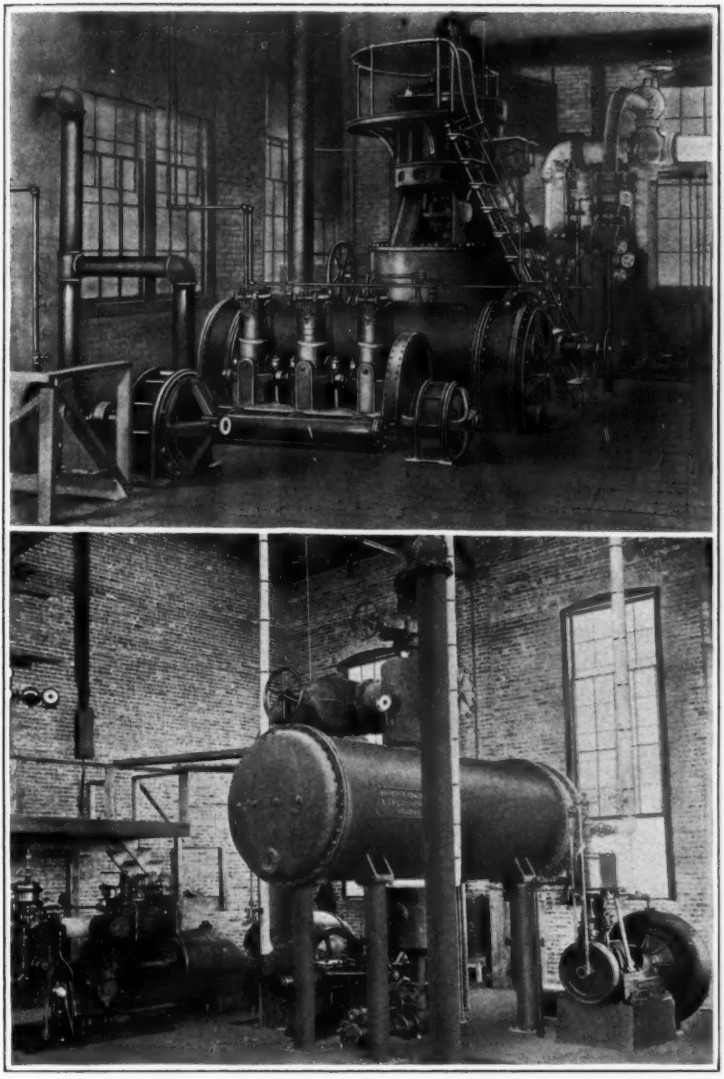
The steam economy of an engine or turbine can be represented by a curve in which the ordinates represent the steam consumption and the abscissa the load, and this method supplies the best and most satisfactory comparison of the results to be expected. The engine curve will usually have a minimum between ⅔ and ⅞ of its rated capacity, from which it rises quite sharply in both directions; the turbine curve is flatter, and rises gradually in both directions, showing that the economy is sustained over a wide range of loads. Tests have been published in Germany showing, in reciprocating engines operating on superheated steam, an economy running under 10 pounds per indicated horse power, which is about equivalent to 12.4 pounds per electrical horse power. Last February Mr. Henry G. Stott, in his paper before the American Institute of Electrical Engineers, gave curves for a reciprocating engine showing an economy of 17.02 pounds per kilowatt on dry saturated steam, and for a turbine showing 14.6 pounds on superheated and 16.9 pounds on saturated steam; these figures are per kilowatt delivered at the switchboard and are respectively equivalent to 12.7, 10.85, and 12.6 pounds

of steam per electrical horse power; these results are based on units of 5,000-kilowatts capacity and would be slightly increased for smaller units. It is questionable, however, whether the builders of steam turbines would guarantee, or upon test would be able, at the present time, to secure an economy of 11 pounds of steam under favorable conditions.

The jet condenser was the earliest type; in addition there are as later developments surface, barometric, and injector condensers. The surface condenser is very widely used in marine work, and while there has always been more or less trouble due to corrosive and electrolytic action, causing holes in the tubes and contaminating the feed water, such action is intensified when the circulating water is drawn from a harbor polluted by sewage, and in some locations the acid refuse from chemical works is met with; an additional source of trouble arises from the stray currents of local electric railways which seek out the water-supply pipes and thus reach the condenser. As the water bill of a large plant runs from $\frac{1}{15}$ to $\frac{1}{10}$ of the fuel bill amounting to several thousand dollars per month in some cases where the water is wasted, it can be seen that there is considerable incentive to reduce this loss by the use of surface condensers. Condenser tubes are usually specified as brass and in some cases it is insisted upon that they be tinned; the value of tinning is rather doubtful, as such a coating would be cut very fast by the small grit carried in suspension in the circulating water; the quality of the brass is often not specified and this leaves considerable latitude to the maker. In the vicinity of New York it has been found that a tin-copper alloy works better in condenser tubes than brass, which is a zinc-copper alloy.

One of the mistakes made in condenser construction is that the tubes are set level. These tubes deflect between their points of support and this slight hollow permits a small amount of water to lie in the bottom of the tubes during the time the condensers are not in use, which causes considerable mischief; nine-tenths of the pitting which occurs takes place in the bottom of the tubes close to the point of maximum deflection. Means should also be provided for the water to drain from the water chambers; a small hole drilled in the bottom partition will allow the water to flow to the lower chamber and not short circuit enough of the circulating water to make an appreciable difference in the efficiency of operation of the condenser.

Condensers are often rated by horse power; a more rational method is by the number of pounds of steam they will condense per



CONDENSING OUTFITS IN MODERN AMERICAN POWER PLANTS.

The upper figure shows a 500-kw. Wheeler condensing unit, including Edwards air pump and centrifugal circulating pump, for Curtis turbine installation, Waterloo & Cedar Falls Electric Co. The lower is a 500-kw. Wheeler condenser with rotative dry vacuum pump, vertical engine direct-connected to centrifugal pump, installed with Westinghouse-Parsons turbine at power plant of Griffin Wheel Co., Pullman, Ill. Wheeler Condenser & Engineering Co

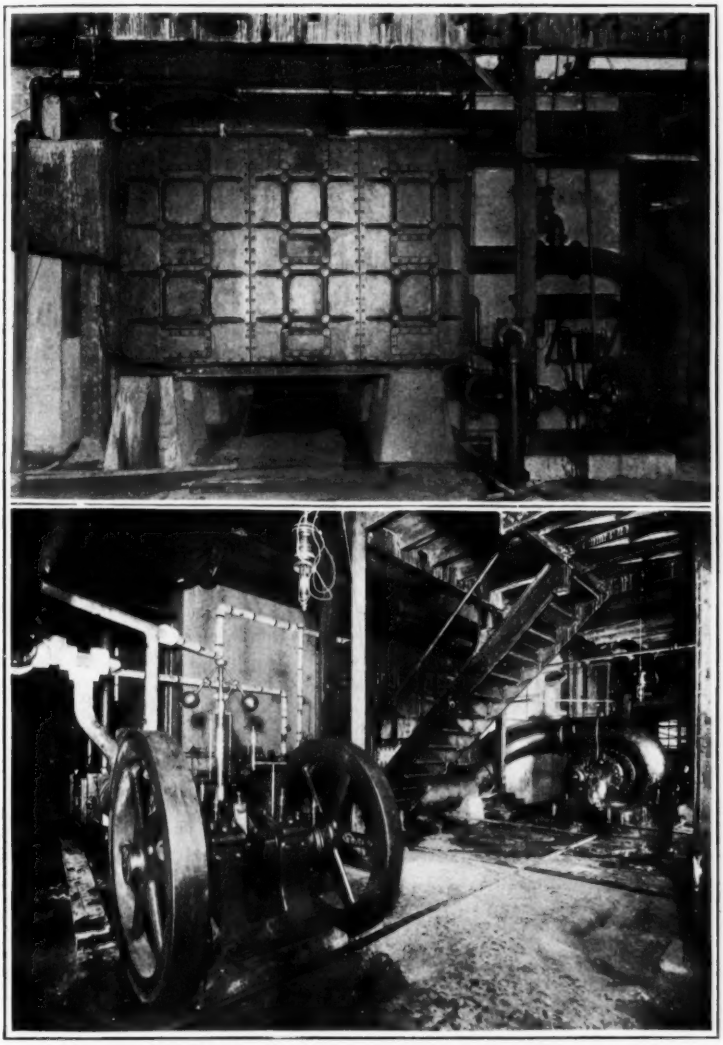
hour; in part this depends upon the vacuum desired. In surface condensers from 6 to 10 or more pounds of steam per square foot of cooling surface per hour are usual proportions, the higher vacuums requiring an increased cooling surface.

The removal of the non-condensible gases is essential to the proper action of a condenser; their action is peculiar, as the reduction in the efficiency of the condenser is much greater than the mere presence of such gases would seem to imply, the probable explanation is that these gases collect in the moisture on the tubes and act as a heat insulator.

In both the barometric and the injector condenser, the condensed steam passes off with the injection water, and is wasted where salt circulating water is used; for this reason such condensers are better suited to localities where fresh water is available for this purpose, but they are often employed with salt injection water owing to the desire to avoid the troubles found in the use of surface condensers and to a lack of faith in the efficacy of oil separators. The injector condenser is the simplest. The barometric condenser for high-vacuum work requires an air pump. In both of the above a tail pipe of about 34 feet in length is used to prevent water reaching the cylinder of the engine.

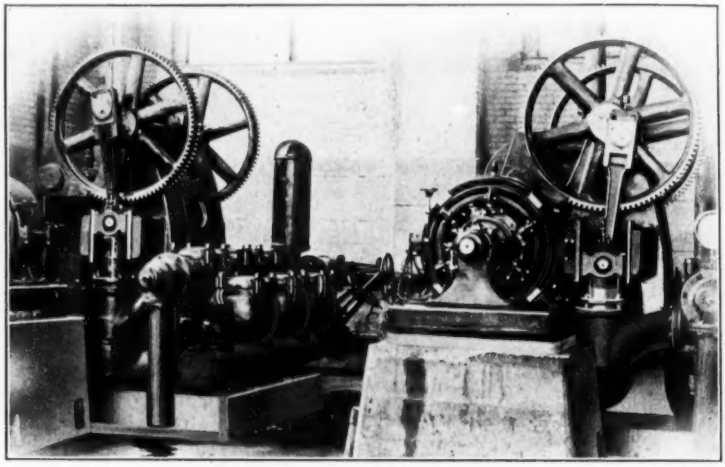
With small surface condensers and ordinary vacuums the wet vacuum pump was practicable; but for high vacuums, as required for turbines, it was found that a separate vacuum pump was required which brought surface-condenser practice into line with that long followed in barometric condensers where the dry vacuum pump had long been used. The advantages of this practice are due to the fact that air compressor lines can be followed in the design of this pump and much better results secured than in a pump cylinder designed to handle a mixture of air and water. The air cylinder is usually designed to have the piston sweep through a volume of one-half to six-tenths of a cubic foot for each pound of steam to be condensed, with a piston speed running from 350 to 450 feet per minute. The valve of the air cylinder is often so designed that before the commencement of a suction stroke the clearance is connected with the other end of the cylinder; this greatly increases the volumetric efficiency, as the gases in the clearance are reduced from atmospheric pressure to practically that of the condenser before suction commences; at the same time the amount that the gases in the opposite end of the cylinder have to be compressed is reduced.

The amount of circulating water varies with the vacuum and its



CONDENSING OUTFIT, GOLD STREET STATION OF THE EDISON ELECTRIC ILLUMINATING CO., BROOKLYN, N. Y.

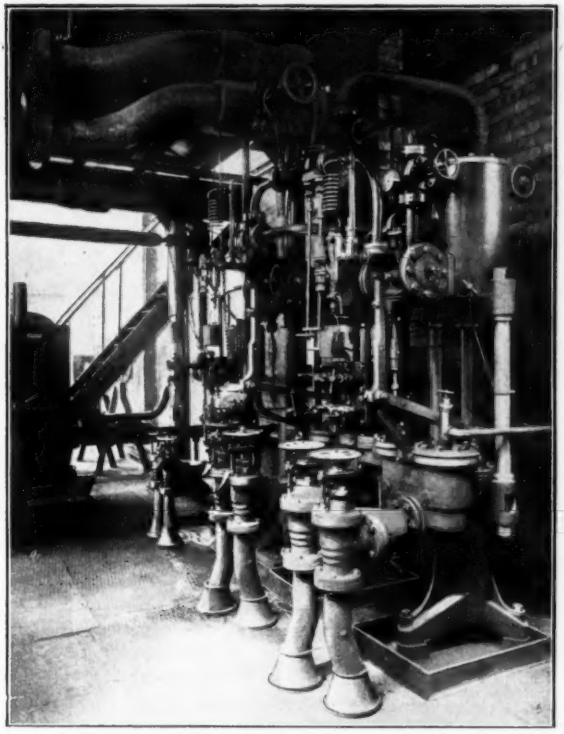
The upper view shows one end of the condenser, with wet vacuum pump. The lower shows the dry vacuum pump in the left foreground, the centrifugal pump at the extreme right, with the end of the condenser behind the stairway. Alberger surface condenser, 25,000 sq. ft. of 1-in. brass tubes; 30-in. double-suction centrifugal circulating pump, 24-in. Corliss dry-vacuum pump, steam-driven, 8-in. centrifugal wet-vacuum pump, electric driven. Capacity 180,000 to 220,000 lb. steam per hour.
Alberger Condenser Co.



INSTALLATION OF BOILER-FEED PUMPS, POWER PLANT OF ATLAS PORTLAND CEMENT CO., HANNIBAL, MO.

Two 9 by 12 Goulds pumps driven by Sprague variable-speed motors. Boilers of 4,000 horse power, 175-lb. pressure. The Goulds Mfg. Co.

initial temperature, ranging from 25 to 90 pounds per pound of steam; for handling this water either piston or centrifugal pumps may be used; with the former the piston speed varies from 150 to 250 feet per minute and outside packed plungers should be used; these pumps are generally duplex compound and are occasionally provided with the Corliss valve motion. Owing to their slow speed they are more expensive than centrifugal pumps for the same duty; they are also more complicated. Another disadvantage common to this type of pump is that the designers apparently work on the idea that it will never be necessary to take any part of the machine down for repairs or renewals except the water valves and the packing; the result is that with the exception of the parts noted it takes from four to ten times the amount of time and labor that would be required to repair a properly designed machine. Centrifugal pumps are coupled direct to the engine or motor, and owing to the high speed at which they run require only as much floor space as a vertical plunger pump of the same capacity. Owing to the small number of parts they are easier to get at and repair; one of the points to be looked out for is that the machine is so designed that the runner can be removed without entirely disconnecting the pump; this is particularly the case where balanced suction pipes are used.



TWIN COMPOUND FEED-PUMP SET, IPSWICH CORPORATION TRAMWAY POWER STATION.

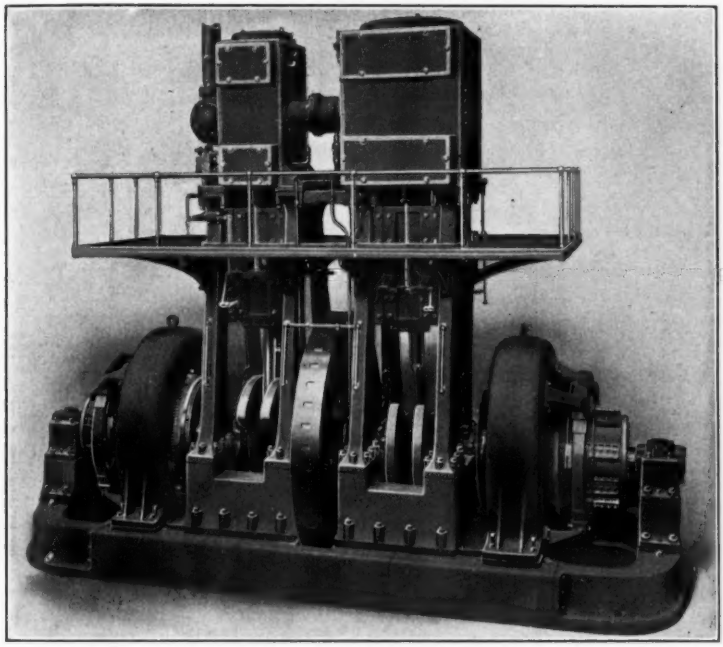
Steam cylinders 19 and 10½ in., water cylinders 7 in., stroke 18 in. Set consists of two Weir pumps, usable independently or as a compound, each capable of delivering 3,000 gals. per hour against 160-lb. pressure. G. & J. Weir, Ltd.

With surface condensers and dry vacuum pumps a special pump is required to drain the condenser; should plunger pumps be employed with closed heaters, the pumps can be used for boiler-feed purposes. The more usual plan is to have these pumps deliver to a hot well in which a prearranged water level is maintained by the use of float valves which admit the amount of make-up water required. Small centrifugal pumps can also be used for this purpose; in this case it is necessary to put some sort of a check valve between the pump and the condenser in order to maintain a vacuum. These small pumps can be driven by motors with advantage, owing to the high speed at which they operate.

The boiler-feed pumps are preferably of the duplex, outside-packed plunger type with "pot" valves; the water ends should be brass-fitted throughout, and the rods should be of bronze in order to avoid all chance of the pumps sticking at a critical moment; the piston speed of these pumps should not be over 100 feet per minute as a maximum, nor from 60 to 75 feet under normal conditions. It is a good plan to use liberal proportions in selecting a pump for this purpose. Occasionally triplex electrically driven pumps have been tried for boiler feeding, but they have not in practice proved as satisfactory as steam-driven pumps. A steam pump will go under almost any sort of conditions as long as steam is turned on; it is impossible to drown them out even when the pump room is under water.

There has been considerable controversy in regard to the comparative merits of steam or electrically driven auxilliary machinery, and it would be feasible to assume a hypothetical case which would discredit either one or the other; in theory it is perfectly simple to assume a set of conditions and from them arrive at a result showing the value of doing a certain thing in a certain way, and it is perhaps unfortunate that the actual load and operating conditions of a plant when built never agree with the preliminary assumptions. Steam-driven machines will operate under conditions that would put an electric motor completely out of business; in addition there is more likelihood of interruptions occurring due to troubles on the main electrical circuits inside the plant than in the steam pipes; for this reason it seems as though continuity of operation would be better insured by the use of steam-driven auxilliaries; in addition to this, the exhaust steam from these machines can be used to advantage in feed-water heaters; this procedure returns to the boiler the greatest portion of the heat rejected in such machines, and this heat can be used with advantage in the feed water even should economizers be installed. With electrically driven auxilliaries there is one advantage; long runs of steam and exhaust piping are avoided, and it is certainly much easier to run electrical conduits than it is to run steam piping.

At one time it was customary to drive the auxilliaries direct from the main engines, in order to secure the steam economy of the larger unit. This practice was more prevalent in England, where large numbers of marine engines were built in this way, and the precedent had to an extent a certain influence in directing stationary-engine practice. In the United States such auxilliaries were occasionally belted to the main machinery, and some directly driven were used.



PORTER-ALLEN ENGINE DRIVING GENERATORS FOR A POWER PLANT.

One of five units, new power house of John Wanamaker, Phila. The two larger engines are 30 and 52 by 36 in., each driving two 500 kw. direct-current dynamos; the three smaller ones are 18 and 30 by 30 in., each driving two 175 kw. generators.
Southwark Foundry & Machine Co.

This method has rather lost favor, and at present even in marine work it is becoming customary to employ independent air and circulating pumps. With independent auxilliaries, it is possible to establish a vacuum before the main engines are started.

THE REDUCTION OF MINING COSTS BY ELECTRIC OPERATION.

By Dr. Alfred Gradenwitz.

Attention is being increasingly drawn to the advanced study of cost reduction forced upon Continental mining engineers by the severe economic conditions amid which they are placed, and to the excellent results they are securing in many directions. The example cited in Dr. Gradenwitz's article would seem also to have applications equally promising outside the mining field. —THE EDITORS.

OWING to the heavy fluctuations in load attending most mining operations, accumulator batteries would seem to be destined to prove especially valuable in mining plants, by virtue of their compensating action—their capacity for storing the current generated during a temporary excess in power, in order again to yield this during periods of greater power requirements. In fact, of all the manifold machines used in mines, only ventilators and pumps are worked under uniform conditions of load for some length of time. All other mine machinery is subject to considerable oscillations in load, depending on the actual work done by the miners, which in turn is influenced by the difficulties met with in working each given product, according to the location and character of the latter. These differences in working are bound to result not only in load fluctuations, but even in real shocks. This applies in the first place to winding engines which, after the filled trucks have entered the cage to be lifted, have to start with full load, and are afterwards accelerated up to their maximum admissible travelling speed. Fluctations quite similar to those of a main pit-winding engine, though on a reduced scale, will be met with in capstan working and horizontal hauling.

Considering these inevitable fluctuations in load, it will be readily understood that the driving steam engine, or the electrical power station supplying the mine with current corresponding to its maximum energy requirements, must work as an average at only 20 to 30 per cent load, apart from the fact that there is generally a convenient reserve for the case of break-downs. These extremely unsatisfactory load conditions are bound to result in an enormously high consumption of fuel in comparison to the work actually done; this consumption can be reduced only by a convenient compensation—that is, by storing the available amount of energy during periods of small loads and utilising this stored energy during times of heavy loads.

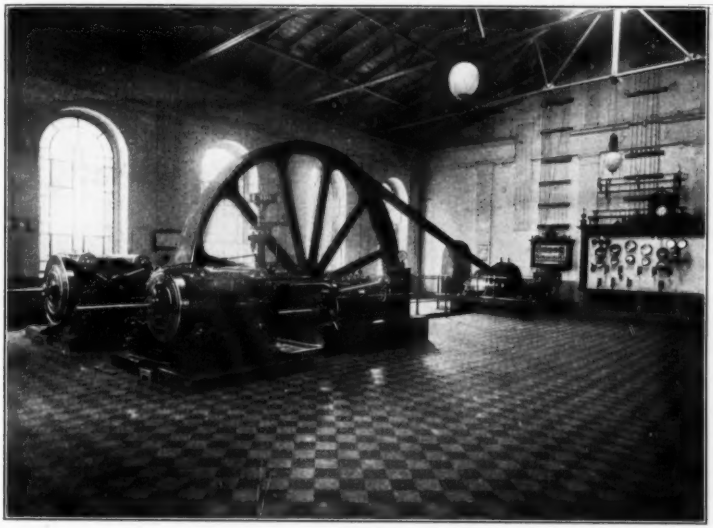


FIG. 1. STEAM ENGINE WITH 100-KILOWATT GENERATOR, GEWERKSCHAFT CARLSFUND MINES.

As electricity is being used to an ever increasing extent in mining plants, it has been found convenient recently to effect this storage by means of accumulator batteries which, apart from warranting an efficient buffer action, constitute a constant reserve to be drawn on at a moment's notice in the case of any break-down. Furthermore, accumulators can be used at any time for supplying current for lighting and power purposes, after stopping the current-generating machines. This satisfactory compensating effect of accumulators on the generation of current and corresponding favourable conditions of the load on the current generators (resulting in turn in a decrease in the fuel consumption of the steam engines and smaller dimensions of the machinery) are by no means confined to direct-current plants, as is supposed by many engineers, but can be taken advantage of as well in polyphase-current plants, which for many reasons, are preferred in mining installations.

The following is a description of an accumulator plant exerting a buffer effect on the polyphase-current system, and thus ensuring a uniform, extremely satisfactory load on the generators. This plant, which is the first of its kind, has been recently installed at the Gewerkschaft Carlsfund Mines, at Gross-Rhüden, Germany.

Electrical operation, which apart from the lighting service was to be used for power transmission only at those places at which the in-

stalling of special steam engines would not have been economical, or the laying out of transmission belts would have met with difficulty, is in this mine extended to underground lighting and mining machines, as well as to the motors and lighting systems at the factory, offices, administration building, and dwelling houses. Though these plants were designed with a view to ensuring a high economy, the current generators, and accordingly the driving steam engines, were soon found to work under unsatisfactory load conditions. While during certain hours of the day the 100-kilowatt polyphase-current generator (Figure 1.), driven by belt transmission from a precision steam engine, was hardly able to cope with the energy requirements, it was as an average subjected only to 30 per-cent load. Two other generators of 50 and 35 kilowatts respectively, set apart as reserves, for special reasons, could be used only rarely for operation, which obviously made the whole service rather uneconomical.

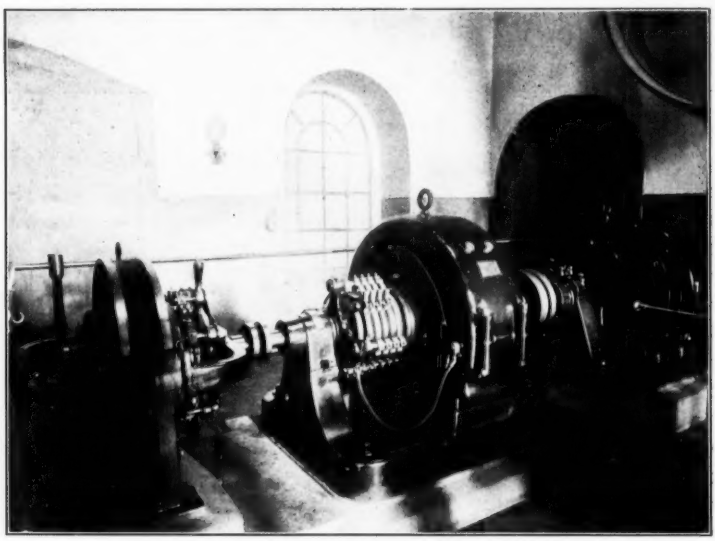


FIG. 2. MOTOR-GENERATOR SET WITH SINGLE-ARMATURE CONVERTER.

In order to increase at the same time the economy and safety in operation of their electrical plant, the managers of the mine decided on installing an accumulator buffer battery, thus obtaining both a compensation in the generator load and a reserve for the case of interruptions in current generation. To this effect the existing 35-kilowatt generator was fitted up and inserted according to a patented arrangement between the polyphase-current system and

buffer battery. This battery comprises 120 cells of a capacity of 648 ampere-hours with a charging and discharging current of 216 amperes.

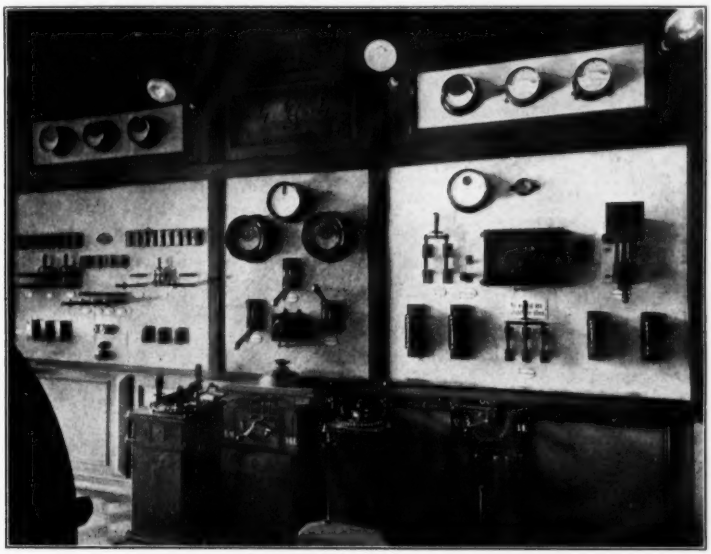


FIG. 3. SWITCHBOARD.

The buffer battery is connected, without the intermediary of any additional cells, cell switches, or resistances, with the terminals of the direct-current machine from which it is charged in the case of a light load on the system—that is to say, whenever this is supplied from the central station with a current intensity superior to actual requirements, while it yields current to the same machine in the case of heavy loads—that is to say, whenever the energy requirements of the connected motors and the lighting service are greater than corresponds to the current derived from the circuit.

As many as 1,024 incandescent lamps, 25 arc lamps, and 30 electromotors (aggregating 250 horse power) are connected to this switchboard, representing a total of 370 horse power or 300 kilowatts.

In Figure 4, A represents the main polyphase-current dynamo, in parallel to which a motor-generator B C, to the direct-current end of which the accumulator F is connected, has been inserted into the rotary current circuit H J. The latter further comprises in series a transformer G, feeding the converter D which is mounted on the same shaft as the motor-generator. The direct current generated in

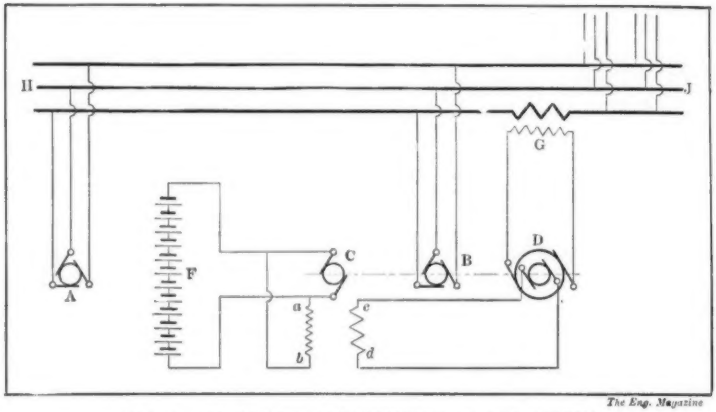


FIG. 4. SCHEMATIC ARRANGEMENT OF THE SYSTEM.

D, according to the series connection of the transformer G with the rotary current system, is proportional to the current intensity traversing the latter and is used for regulation by flowing through the coils *c d* in opposition to the separate excitation *a b* of the magnets at the direct-current end C of the motor-generator B C. As the current intensity in the polyphase-current circuit is increased, the potential of C is thus reduced so that, the accumulator being discharged onto C, the polyphase-current circuit end B of the motor generator will yield current to the polyphase-current circuit, while in the event of the current intensity in the polyphase-current system decreasing, the tension of C is increased, charging the accumulator battery.

As seen from Figure 4, the arrangement does not comprise any relays or delicate mechanisms, thus avoiding any risk of trouble, while the immediate utilization of the current available for regulation in any desired intensity, as well as the efficient means of regulation, will warrant a rapid and safe operation of the accumulator.

Whereas the 100-kilowatt dynamo had to work continually before the installation of the buffer battery, under an average load, during the day of 30 per cent, even the 50-kilowatt dynamo has been found now to be sufficient for operation and to leave some excess. While the 100-kilowatt dynamo previously worked during 24 hours every day, a 17-hour service of the 50-kilowatt machine is now sufficient, the polyphase-current circuit being fed during the remaining time from the accumulators with the aid of the converter B C.

The average load on the dynamo is obviously somewhat greater, the accumulator having to be charged during the day-time, while the

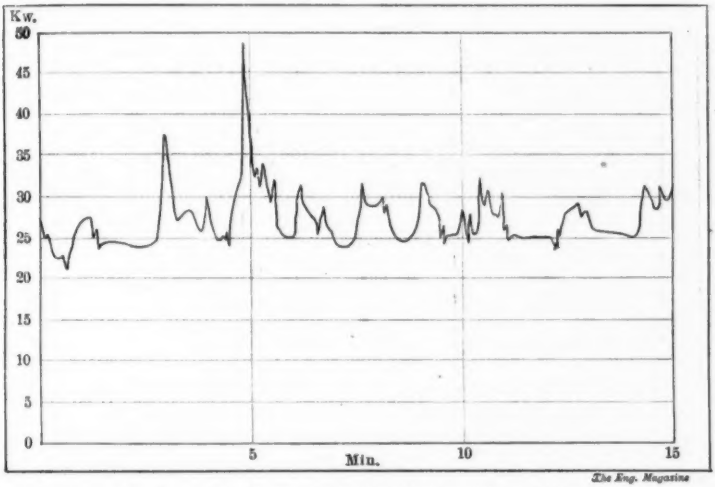


FIG. 5. KILOWATTS OF POLYPHASE-CURRENT CIRCUIT.

energy requirements have been augmented by the addition of some further connections. These conditions are, however, the more satisfactory to the machine, as the output approaches more closely to its normal and most satisfactory figure.

Some interesting measurements recently made in this plant with self-recording instruments are plotted in Figures 5-8. As seen from Figure 5, the requirements of the polyphase-current circuit during the time the tests were made oscillated between 22 and 49 kilowatts, while the potential at the bus bars of the circuit, as seen from Figure 6, varied only by ± 2 per cent. The most interesting curve is that of

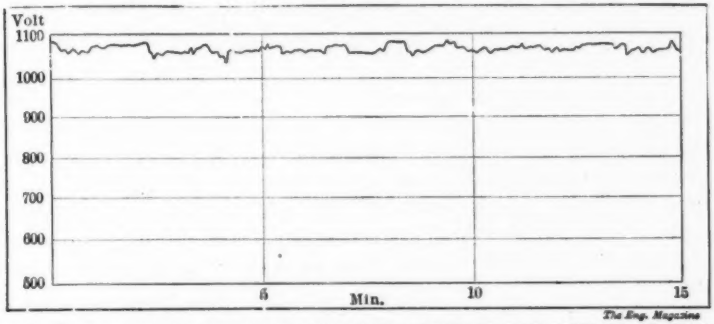


FIG. 6. TENSION OF POLYPHASE-CURRENT SYSTEM AT BUS BARS OF CENTRAL STATION.

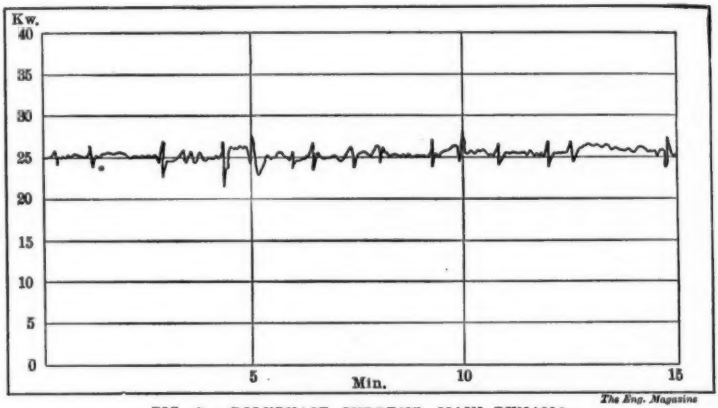


FIG. 7. POLYPHASE CURRENT, MAIN DYNAMO.

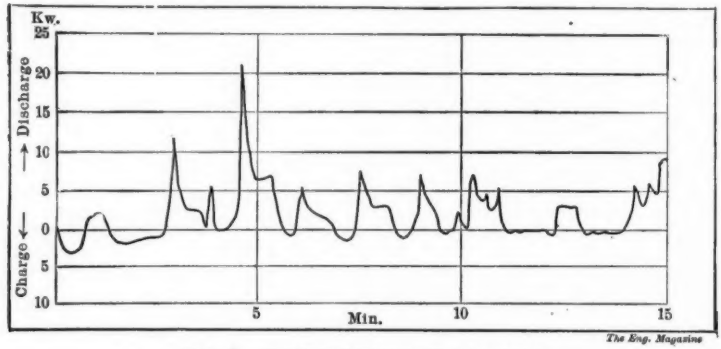


FIG. 8. BUFFER DYNAMO IN PARALLEL.

Figure 7, showing the output of the main polyphase-current dynamo to have been kept at the practically constant figure of 25 kilowatts.

Figure 8, illustrates the behaviour of the current intensity thrown by the parallel polyphase-current buffer dynamo B. (Figure 4) into the polyphase-current circuit, or derived from the latter. The curve was recorded during a period in operation when the accumulator was nearly exclusively being discharged. However, the plant will work under the same satisfactory conditions whenever the current continually passes from charging to discharging. The entire operation has been carried out without any hitch since the addition of the buffer batteries, while such complaints as were previously made in regard to unsteady and unsatisfactory light, have ceased entirely. Apart from increasing the safety in operation, the cost of operation has been reduced from 4 cents to less than 3 cents per kilowatt hour.

A SYSTEM FOR OBTAINING FOUNDRY COSTS.

By C. J. Redding.

It is a matter of common observation that the foundry has only lately come in for attention anything like proportionate to its merits, or to that long given to the machine shop. In this paper and in others by practical foundry men to follow we purpose to discuss some of the most important points in the management, not simply of the foundry *per se*, but of the foundry as an organic part of the machine shop or machinery-building establishment.—THE EDITORS.

THE casual methods which many foundry managers have of ascertaining the cost of the various castings made in their shops have always been a matter of surprise to me. One of these methods, which is almost universal throughout the trade is to assume that the total wages paid, plus the total material bought, divided by the castings produced, equals the cost per ton or hundred-weight. This, of course, is quite correct as an average. It would be useful in a shop in which only standard work was made, but as soon as any variation occurred in the class of castings turned out, what would be the use of the average cost?

Another system of costing is, for the foreman to say a certain casting costs "so much per hundred-weight," and it is charged at that price. There are no data on which this price is based, except the foreman's estimate. Of course it is a very simple method of doing the work and what perhaps is of great importance in most foundries, it does not cost much. It also relieves the foreman of a lot of worry, because he is careful not to charge any casting at a higher price than it is sold for and consequently no awkward questions are asked by the manager as to why certain castings cost so much to produce.

A third system, which is an improvement on the preceding ones, is to analyze the wages, material, and output under the headings of loam, green, dry, and open sand castings and thus arrive at an average price per hundred-weight for each group. This system fails for the same reasons as the first. When this cost per hundred-weight has been obtained, of what use can it be, as a basis for the selling price of future orders? Consider for a moment the variety of castings produced of each group. For instance, take a pump body which

has been designed for a high lift and another for a low lift, both to deliver the same quantity of water and both of exactly the same design, except that in one case the metal is 1½ inches thick and in the other 1 inch or ¾ inch thick. The work in each is exactly the same, but the weight in one case is from 50 per cent to 100 per cent greater than in the other. It does not cost any more in wages to make one than it does the other. Now if the cost of the high-lift pump is based on that of the low-lift, then the difference in the weight of material (that is the metal only) is being charged at 15 shillings or 20 shillings per hundred-weight (the value of the whole casting) instead of say 5 shillings per hundred-weight, which is approximately the cost of the metal only. Thus the whole casting is being charged at a price far above actual cost. If the cost of the low-lift pump is based on that of the high-lift, then it is being charged at less than the cost. This illustration alone shows the absurdity of this method.

This is not an isolated case, as every foreman knows. Similar variations occur in every group of castings, whether they are loam, green, dry, or open sand. Of what use therefore is the average cost, even of any group of castings?

What is the end of most foundries where "average costs per hundred-weight" is the method used for arriving at costs? For years, possibly, a foundry may be fortunate in getting a good supply of high and low grade castings to make, and as long as the ratio of high to low-grade is kept constant, the average price per hundred-weight will probably show a profit at the end of the year. Supposing this ratio is not maintained, and more castings of a high than of a low grade are included in the output; then the profit at the end of the year has probably disappeared entirely. The manager, of course, sees this at once, and naturally increases the charging price for the next year. This would overcome the difficulty, provided he could be certain that the type of casting would be the same as that of the preceding year. But what manager can rely on the type of castings he may have to produce in any future period? Assuming that the price is raised and a preponderance of either high or low-grade castings is ordered in the coming period, the same trouble arises. They are charged either too high or too low. If too high, then probably orders which would give a good profit are lost; if too low, then another loss is shown at the end of the year. So the thing goes on, until the shop is shut up as it does not pay to run it.

I have often been struck by the extreme care taken to ensure the accuracy of cost figures in connection with the machining and assembling of castings, when the cost of the castings themselves is nothing more or less than a guess. What is the use of exact cost in the machining department of an engine shop when 75 per cent of the material used in the construction of the engine is pure guess work as regards cost? If an average cost is good enough for the castings, why is it not so for machining them? Most engineering firms seem quite satisfied with this method; yet is it logical to expect that estimated plus actual costs will give actual total costs? This is what is expected in most firms, and strange to say the result appears to satisfy the directors.

I propose to illustrate a method by which all estimating is eliminated from foundry costs. In these days of keen competition it is necessary for every manager to know what every article costs to produce. If the cost price be too high for the market, then it must be lowered; but the manner some managers have of lowering the cost by simply reducing the charging price per hundred-weight for the castings, without improving the method of production and thus lowering their actual cost, is not business like and can only result in loss at the end of the year.

Is it possible that the bad trading results of so many engineering firms, converted into limited companies, are the consequences of the actions given above? In many cases one sees the balance sheet of a firm, which has been turned into a public company, showing a decreasing profit each year. Is it due to the fact that the former owners kept a strict watch over the foundry, and estimated fairly accurately the cost of the output, and that, when this supervision was relaxed on the firm being converted into a company, the cost of the castings was left in the hands of the foreman or charged at an average rate, without any practical supervision? I maintain that mismanagement in the foundry is the cause of the poor balance sheets of many public companies. In any case it is absolutely necessary for every manager to know the actual cost of his productions, and this can not be obtained by the methods given in the preceding pages.

With the following system the actual cost of each casting can be obtained without any guess work at all. As a result of the inauguration of this system several foundries have increased their output from 5 to 15 per cent, and this without any great extra expense.

Copies of the various orders and other forms are given, but these can, of course, be altered to suit the requirements of each shop. The principle is the chief thing, and so long as accurate results are obtained, the details are of no great importance and can be modified to suit special or individual cases. This system is applicable to brass and iron foundries, the same rules applying to both.

On receipt of an order to build any engine, machine, etc., it is entered in the works order book and the order for the castings should be made out in detail in a carbon triplicate manifold book. One copy should be retained in the office as a record of having ordered the castings, one should be sent to the pattern shop, in order that the patterns may be prepared and sent to the foundry, and the third copy goes to the foundry. The order to the foundry should be double the size of the other two copies and should have "Foundry" printed on; the pattern shop copy should have "Pattern Shop," and the office copy "Office" printed on. The pattern shop and office copies should be printed as follows on fairly thin paper:—

PATTERN SHOP.

Page No._____

Date_____

ORDER No. _____

Tracing No._____

Deliver to_____ for_____

Reference letter	No. Wanted.	Material.	Pattern.	D DESCRIPTION.

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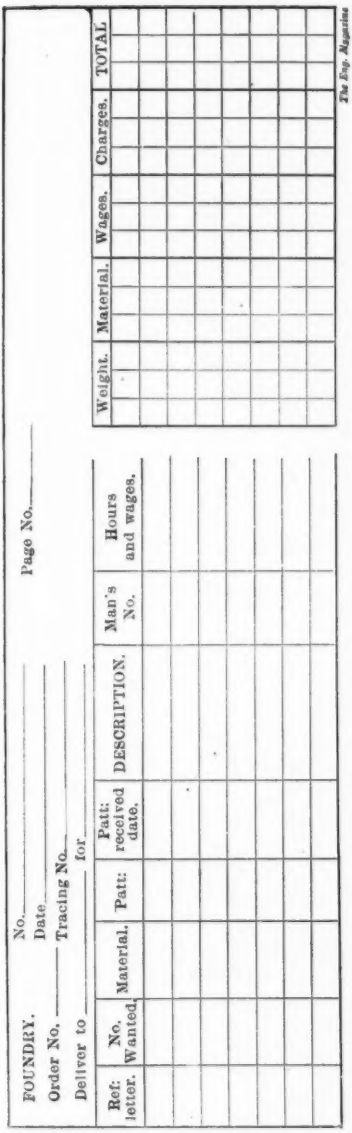
FORM 1. ORDER FOR CASTINGS.
Made out in triplicate, for office, pattern shop and foundry.

The copy kept in the office should not be perforated, but the pattern and foundry order forms should be perforated so that they can be easily torn out of the manifold book. This book must be paged so that the three copies have the same page number. It should also be provided with a few blank pages in front, so that an index can be made. It is necessary to index only the order



FORM 2. HEADINGS AND RULING. THE SHEET MAY BE MADE AS DEEP AS DESIRED.

number and the pages on which the same order numbers occur. If preferred a more detailed index can be made, but experience has shown that it is not necessary.

The foundry office order must be made as follows:—

The left hand half is exactly the same as the first two copies, with the exception that it is headed "Foundry" and has a space provided in which to record the date of the receipt of pattern in the foundry. The right-hand half is entirely different as will be seen by examining the form given above.

All the castings required for each drawing should be ordered at the same time, using two or more forms if necessary. In the case of a large casting, likely to take some time to make, or of any number of castings off any one pattern, two or three lines should be left to record the necessary information. This order form should contain the tracing and order numbers, and the number of castings required off each individual reference letter on that tracing. When these order forms are received in the foundry, they should be placed in numerical order according to the order, not the page number, and be held in a strong paper clip.

DAILY TIME BOOK

Man's No. . . . . .

Name_____ Rate_____

Order No.	Tracing No.	Ref. Letter.	DESCRIPTION OF WORK.	Pattern No.	Daily time.							Total time.	Amount of Wages.			Remarks.
					Wed. Night	Th.	Fr.	Sat.	Mon.	Tue.	Wed.					
(8)																
												Total				

584

FORM 3. DAILY TIME BOOK.

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Every pattern received in the foundry should pass through the foundry office and the clerk should enter on the order form the date it was received. No pattern should be passed into the shop until this has been done, so that all disputes as to whether a pattern is in the shop or not, or as to when a pattern was received, are avoided. Many instances have occurred of the foundry being blamed for not having made certain castings when the pattern itself has not even been delivered, the order for it having been overlooked in pattern shop.

Every pattern sent to the foundry must have a card tacked on, containing the following information and printed as follows:—

IRON FOUNDRY. Order No. _____

Tracing No. _____ Reference _____

Date _____ Man's name or No. _____

No. wanted.	Pattern.	DESCRIPTION.	Weight.		

Foreman _____

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FORM 4. CARD TACKED TO PATTERNS SENT TO FOUNDRY.

The pattern maker fills in the spaces for Order No., Tracing No., Reference letter or pattern number, and the number of castings required. He obtains this information from his own copy of the manifolded order. The foreman moulder fills in the man's name or number and states if any particular mixture of metals is to be used in the casting. This is all done before the pattern is given to the moulder to make the castings.

Up to this point almost everything is according to the usual practice of all foundries, but now a great alteration is made. This alteration consists in taking the time of every man, boy, and laborer in the shop, and recording it daily in a time book ruled as in Form 3. The clerk should go round the shop every morning or afternoon, or even twice a day, and take the time of everybody employed, ex-

cept the foreman. The time every man is engaged on any work must be recorded in this book. No matter what the man has been engaged in doing, it must be entered in this book so that the total number of hours, recorded for each man, agrees with the total hours he is paid each day by the firm. All moulders' time is recorded as making the castings for the various order numbers specified on the cards which are tacked on to the patterns from which the castings are made. The clerk records in time book the order number, tracing number, and reference letter or pattern number as given on these cards, and fills in the time spent each day by the moulder making the casting. In the case of several men being engaged on one mould, then the leading man's time sheet should contain all the above information and the other men's time should be taken as assisting the leading hand in making this particular casting. If any men are engaged making grids, hooks, etc., which can only be used for any one mould, their time must be recorded as such, to that casting and order number. Time making boxes, plates, grids, core irons, which can be used again, must be recorded in the same manner and charged as either new plant, maintenance of plant, tools, or in fact to the account which is provided for them.

Core makers' time should be charged to making cores for each particular casting, and thus to the order, as core making for such casting. In the case of cores made to stock and which can not be accurately allocated to any special casting, the time spent by each man or boy must be recorded as "General Cores" in the time book.

If any men are employed as smiths, fitters, carpenters, etc., in the shop, their time must be taken just the same as any other man, and charged to what they were doing, such as fitting boxes—if new ones to "Plant," if to replace broken ones, to "Maintenance"; making feeder rods, etc., to "Tools," and making runner pegs, to "Tools"; and in fact, all the time spent by these men must be charged in detail to the account which provides for each class of work done by them. Men engaged trimming castings must have their time charged to "Trimming." Furnacemen, and laborers engaged in supplying metal to the cupola, must be charged to "Cupola Laborers" account. Crane drivers, to "Crane Drivers' Account."

Laborers:—All time spent by laborers must be charged to "Laborers Account." No laborer's time should be charged to any casting, even although they were engaged for some little time helping a moulder on any particular casting. The excuse can not be made by any moulder that he did not know what the casting was for, as

every pattern has the card tacked on which contains all the necessary information.

At the end of each week the time of each man on each casting is totalled and extended at the rate of wages paid to the man, and the total of these hours and wages for each man must agree with the weekly pay sheet of the shop.

Any time spent on any casting which is found to be defective is charged as "Replace Casting" and the cost of same must not be included in the cost of the casting which replaces the bad one. This can be done very easily each week or day in the case of castings turning out bad before leaving the shop. In the case of castings which are found to be defective after being machined, or after the cost of them has been made up, then the Moulders account on the analysis sheet for the week they are replaced, must be credited with all the wages spent on the bad casting and the "Replace Account" debited with the same amount. The wages on the replace casting will be charged each week, as paid, to the Moulders account as usual.

After the time book is agreed with pay sheet, the wages are analysed under the various headings as follows:—

Coremakers and Moulders, charged to castings; General Cores not charged to castings; Trimmers; Replace Castings; General Labor; Cupola Labor; Crane Drivers; Plant; Tools; Maintenance. The various headings of this analysis are then cast and the totals agreed with the pay sheet total.

The grand total of wages paid and the totals of each heading of this analysis are posted each week into a "Wages Analysis Summary Book," in the form shown on the following page.

Each month or each quarter, as may be determined, this summary book is totalled, so as to make up the figures for the Foundry Balance Sheet and for checking the accuracy of the returns for any period.

After the time-books are agreed with pay sheets, the clerk posts from these books onto the office order forms the wages and time spent by each man, on each casting, for each order. Coremakers' time and wages should be notified as such, in some manner, so as to distinguish between moulding and core making. A different color ink may be used for posting these wages. This information is very necessary when a casting is found to cost too much. The extra cost must be caused either by the cores, or the moulding; and when the cost of each is known, improved methods may then be

WAGES ANALYSIS SUMMARY BOOK

Week Ending	Moulders & Coremakers charged to Castings	General Cores not charged to Castings	Trimmers	Replace Castings	General Labor	Cupola Labor	Crane-Drivers	Plant (not castings)	Tools (not castings)	Maintenance (not castings)	Total Wages paid as per pay sheet.

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FORM 5. WAGES ANALYSIS SUMMARY BOOK.

got out for doing that part of the work which costs too much. Great care should be taken in posting these wages, as on this depends the accuracy of the cost of the casting.

On completion of a casting, the clerk takes from the moulder the card which was tacked onto the pattern, and records on it the weight of the casting after being trimmed. This, of course, may be done by the man who is accustomed to weigh the castings, but in any case the cards must be returned to the clerk. The weights of all castings made must be obtained and returned to the clerk, no matter whether they are grids, boxes, or plates, etc. If a casting is found to be defective, the weight of it must be charged just as if it were a good one; but instead of being charged to the order, it must, like the wages paid for making it, be charged to Replace Account. This account is then credited with the scrap-iron value of the bad casting.

The furnaceman must make day by day a return of the weight of:—1, each brand of pig iron; 2, scrap-iron bought; 3, all runners, grids, heads, etc., from the shop floor; 4, foundry coke, used in the cupola. It is safer to have this return daily, as these men are apt to be careless, unless kept up to the mark. If the return is made every day, any inaccuracy may easily be rectified. This is a simple method of keeping track of the stocks of iron and foundry coke. These returns, in conjunction with the Wages Summary Book, can also be used for checking the value each week of the output. It is also very interesting and useful to compare the weight of coke used per ton of metal melted, and also the amount of iron melted to produce the castings made.

When a casting is trimmed, the order and tracing numbers with the reference letter also should be painted on some part which is not likely to be machined. This, without much expense, will save a good deal of time spent in the machine shop, in discovering which order number and which tracing number a casting is for. Experience has shown that in many cases castings for a certain order have been machined for another order, at the cost of increased labor, simply because the wrong casting had been taken. It may then be discovered that the casting made specially for the order has to be scrapped, owing to the fact that it will not "clean up" sufficiently, so as to come in for the one which was taken in error. This, of course, is not a common occurrence, but it has happened several times. From the castings cards which the clerk takes from the moulders, or has returned to him by the weigher, the daily delivery

advice is made up. These advice books are carbon duplicate books, printed and ruled as follows:—

ADVICE BOOK To_____ Date_____

Please receive IRON CASTINGS from Foundry as under:-

Order No.	Tracing No.	Ref: Letter	Pattern No.	No.	DESCRIPTION.	Cwt.	qrs.	lbs.

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FORM 6. ADVICE BOOK OF DAILY DELIVERIES OF CASTINGS.

A carbon duplicate, remaining in the book, is identical except that it has at the right columns for extending the price.

The under copy is kept in the foundry, the perforated top copy is sent each day with the castings delivered. It will be seen that the top copy is not ruled with cash columns, but that the under copy is so ruled. It will readily be understood that it is not necessary to inform other departments as to the value of the castings delivered. In writing up this delivery book, care should be taken to note when a casting has been made of any special mixture of iron. This information is obtained from the casting cards on which the foreman, before giving them to the moulder, has stated the special mixture to be used. This is necessary so that the casting may be charged with the correct price of that mixture.

Every day the weights and number of castings delivered must be posted from the advice book on to the office order forms to each casting on each order number. It is most important that this should be done immediately the delivery book is made up each morning. This is necessary so that the foreman or manager can see how each order is progressing, which castings are in progress, and which castings are still to make for any particular order he may require.

On an average, 27 hundred-weight of iron must be melted to produce 20 hundred-weight of trimmed castings. As this 27 hun-

dred-weight of iron is composed of several brands of pig iron, mixed with scrap, the weight of each brand used must be obtained and the balance will be scrap-iron. These separate weights are extended at the prices paid for each. To melt this weight of iron from 2½ to 3½ hundred-weight of foundry coke must be used, and the cost of it added to that of the pig iron. From this 27 hundred-weight of iron, about 5 hundred-weight will be returned in the form of runners, risers, etc., and the value as scrap must therefore be deducted from the above total. The wages of cupola laborers and trimmers must now be added, and the sum will be the cost of the 20 hundred-weight of metal in the trimmed casting. The cost of any special mixture may be obtained in the same manner, as the only items which can vary are the prices paid for the various mixtures used for special castings.

When the weights of castings are posted on the office order forms, they should be extended at the price of the mixture used.

Where several castings are required off one pattern, it is advisable not to extend the cost of the material until all the castings are completed, as it is almost impossible to keep the cost of each one separate. Until the whole number is completed, only the weight and number made should be posted on order forms. Then the total weight should be extended at the usual rate in the ordinary manner.

We have now, posted on the order forms, the wages and material spent on each casting. To these amounts must be added a further sum to cover the expenses of "charges" which are made up of the following:—

Interest on capital expended on land, buildings, and plant.
Rates and taxes.
Power.
Depreciation on building and plant.
Maintenance of building and plant.
Insurance.
Light.
Heating and coke for stoves, etc.
Water, blacking, loam, chalk, fireclay, gannister, chaplets, tools, bricks, straw rope.
Foreman and clerks' wages.
Replace castings.
General laborers and crane drivers.
Sundry stores used in foundry.

Up to this point every item is directly chargeable to the foundry; but we have still to add a further sum to cover the cost of management, etc. This amount must necssarily be an estimate, and should be fixed carefully by the management. After deciding on the amount required it should be added to the total previously obtained for expenses directly chargeable to the shop. A percentage should then be obtained on the wages spent on moulding and core making, charged to this account in the wages summary book. This percentage should cover the total of the charges allocated to the shop. The better and safer way to cover the dead expenses is to charge a percentage on the wages paid for making the castings, instead of on the weight prodnced. Of course it is not an absolute fact, but experience shows that it is as near the actual as can be obtained. It is also very simple and a very quick method of calculating costs. It is more reasonable to allocate the charges in this manner than on the weight. The weight of a casting is no criterion of the time it has occupied room in the shop, nor yet of the amount of supervision and other expenses it has entailed, but the wages on it do show this to a great extent. For instance, a base for a chimney weighing 20 hundred-weight is in the shop for about two days and has entailed no expenses for any drying, chaplets, studs, straw ropes, or in fact anything beyond the ordinary expenses for moulding. Compare this with a slide-valve cylinder or a Corliss cylinder of the same weight, with all the necessasy core irons, cost of drying, the time floor space has been occupied, the extra supervision required, etc. It does not seem logical that both should bear the same charges simply because they weigh the same, when one was in the shop two days and the other probably five or six days.

By allocating the charges in this manner, high-class castings are necessarily charged at a high price and low class at a low price. This is the most logical and therefore the best method of allocating charges.

After this percentage has been obtained, it must be posted in the charges column on each casting on each order form.

The total cost of each casting can now be obtained by totalling the cost of material, wages and charges. This amount should be placed in the total column for each casting on each order form, and also in the cash column provided on the carbon duplicate remaining in the delivery book. (See page 590.)

The total weight and value of castings made each week should then be obtained from the delivery book. These totals must then

be analyzed each week under the various order numbers and sent to the cost department. This will show weekly the amount which has been expended on each order and how each order is progressing.

On the completion of the castings on any order form, the various columns should be footed and agreed with the total cost. These totals should then be posted on the form given below:—

IRON FOUNDRY._____

Summary Sheet for Order

Order page No.	Weight.			Material.			Wages.			Charges.			Total.		

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FORM 7. FORM FOR RECORD OF TOTAL COST OF CASTINGS.

When all the order forms for any order number are completed and added and the totals posted on the summary sheet, the latter should also be totalled and the whole should be sent to the cost department to be filed away with the records of that order number.

This summary sheet will be found most useful in estimating for future orders. It shows at a glance the total weight of castings made, the wages, material, and charges spent on them. Any increase or decrease in either account may very quickly be adjusted to suit the market requirements.

It is advisable to check the total cost of all castings made every quarter at least. It is not a costly proceeding and the result proves the accuracy of the total costs charged and makes a manager feel satisfied that things are going on all right. A form should be prepared as shown on the following page. The scheme there given is descriptive rather than "graphic"; that is, the items chargeable to the respective sides of the account are simply defined.

QUARTERLY CHECK OF PRICES CHARGED FOR CASTINGS.

DATE

Dr.	Cr.
Wages on castings unfinished and on castings for which no value has been charged on order forms taken at beginning of quarter).	Total value of castings charged during the quarter.
Charges on these wages.	The wages on unfinished castings and on castings for which no value has been charged on order forms (taken at end of quarter).
Value of material of castings for which no value has been charged (at beginning of period).	Charges on these wages.
Wages on moulding and coremaking for quarter.	Value of material of castings for which no value has been charged (at end of period).
Charges on same.	
Value of the material of castings charged during quarter.	

Taking each item on the debit side, the wages on all unfinished castings and on castings for which no value has been charged are obtained by totalling the wages on all order forms for castings not completed. The usual charges are added to this amount.

The value of the material of the castings charged without any value on the order forms is obtained in the same way as the wages.

The wages on moulding and core making are obtained from the wages summary book.

The usual charges are added to this amount. The value of the material (only) of castings made, is obtained from the output at the various prices charged for the different mixtures.

On the credit side, the value of castings made during the quarter is obtained from the weekly returns made to the cost department from the delivery book. The wages on unfinished castings, etc., at the end of the quarter are obtained in the same manner as at the beginning. The value of material in these castings is also obtained as at the beginning of the quarter. If this statement does not balance, some mistake has been made in the prices charged for the castings and steps should then be taken to discover and rectify the error.

The consumption of all material used should also be carefully watched, and to do this thoroughly a balance sheet should be prepared at least every quarter. The stock of all material should be taken at the beginning of the period, and to this all purchases during the same period should be added. From this total the stock taken at the end of the same period should be deducted; then the difference must be the consumption during that period. These figures should be placed on the debit side of the account and be extended at the prices paid. The wages on moulding and core

making should then be added, also all wages paid for laborers, trimmers, crane drivers, cupola laborers. These amounts are obtained from the wages summary book. The following items should be added:—

Interest on capital expended on land, buildings, and plant.
Rates and taxes, power, depreciation on building and plant.
Maintenance of buildings and plant, tools, insurance, light.
Heating, water, foreman and clerks' wages, replace account, and the amount determined on by manager to cover management expenses.

The total weight of shop scrap remelted during the period should also be shown, and any difference between this stock at the beginning and at the end of period should also be debited as weight only, without value. These figures are obtained from furnaceman's weekly or daily returns.

Any wages on castings charged without value and on unfinished castings at the beginning of the period, less any wages on similar castings at end of period, should then be added.

On the credit side charge, first, the weight and value of output during the period (these are obtained from the weekly returns to the cost department); second, the weight and material value only of all castings unfinished and of castings charged without value at the beginning of the period, less the same at the end of the period. If the weight and material value only of castings unfinished and of castings charged without value be greater at the end than at the beginning of the period, then the difference must be added; if less, then it must be deducted. Any credit or debit balance will be either profit or loss in the rate per cent added to the wages to cover the cost of dead expenses. This rate per cent should then be altered accordingly.

This balance sheet when examined is found to contain all the necessary information with regard to:—

1. The consumption of coke per ton of iron melted.
2. Waste in melting.
3. The weight of iron melted to produce a certain quantity of castings.
4. Wages (moulding and core making), per ton and any other percentages in connection with the consumption of stores which might be required.

In order that the cost of future castings off old patterns may be checked, all costs should be indexed. The card system is the best for this purpose on account of its being expansive. The castings should be indexed under their own specification, not under

order numbers; cylinders, flywheels, bedplates, etc., being placed under their respective classifications. Full information should be given, so that they may be readily identified. The following specimen cards will illustrate what is required:—

PULLEYS.

9800	Single Arm.	015	C	20"x3"x2" Dia. Fan Bore	1	4¼	.	3	.	.	3	6	Solid, split or in halves as the case may be.

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CYLINDERS.

Order No.	Type.	Tracing.	Refee.	Size.	No.	Hours.	Weight. C	Q	L	Wages. L	s	d	Remarks.
000	Corliss	0000	A	24" x 42"	1	527	100	.	.	20	.	.	New pattern.

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FORM 8. SAMPLE CARDS FOR INDEXING OF COMPARATIVE COSTS.

It is not necessary to give any more information than is shown on these cards. The cost of material varies according to the market and the charges fluctuate according to the conditions of work pre-

vailing in the shop. The total cost of any casting shown on the cards can quickly be obtained by extending the weight at the current price and then adding the wages together with the current percentage thereon for charges. It is important that this indexing should be done correctly, as every one can see that a great deal depends on it as regards the output of the shop. As soon as an order form is received in the shop, it should be compared with the index cards and if any similar castings have been made, the time and wages spent on the previous order should be put in pencil on the new order forms. In the case of repeat castings the time and wages spent on the previous order should be placed in a rough note book and when the clerk is taking the daily time of the men, reference should be made to this and if there be any increases or decreases in the time charged on the repeat castings they should be brought to the foreman's notice at once. The reasons for such increases or decreases should then be noted on the orler forms.

When posting from time book to order forms, the clerk can see from his pencil notes if any cost is increased or decreased, and any differences should be brought to the foreman's notice also. When a large casting is being made, which wohld probably be in the shop two or three weeks, and the cost is approaching that of the last one made, the foreman should be notified so that steps may be taken to prevent the previous cost being exceeded if possible.

In the case of castings to be made by apprentices, etc., it is advisable that these patterns should be marked in some manner so as to prevent them being given to full-rated men to mould. Many instances have been brought to notice of men being given orders to make these castings when apprentices have formerly made them. If the patterns are marked in some manner they will only be given to the proper persons to make, as the foreman will take particular care of this so as to avoid being asked the reason for changing his methods of working. This is not an isolated case but one that is quite common in most shops, and one that should be avoided.

The cost of this system may be thought, from the details given of the work, to be very great. In actual practice it is not so; the actual cost of running this system in a shop with an output of 4,500 tons, only amounted to £150 per annum. The staff consisted of one good clerk and a smart junior. This cost can not be considered high when all the advantages of the system are realised. The following are some of the advantages claimed:—

1. The foreman need not be bothered answering any questions about castings made or unfinished or not made at all, as the clerk by turning up his order forms can see at a glance which patterns have been received, which have still to be received, which castings are made, which are not made and those still in progress.

2. The foreman can also obtain from these forms the above information every morning and is thus able to arrange his work accordingly. By this means the foreman's time is saved considerably and the output is increased owing to the fact that the men know a strict supervision is kept over all time charged.

3. A close watch can be easily kept on the cost of production, also on the consumption of all iron, coke and stores.

4. The advantages or otherwise of various makes of foundry coke can be accurately determined without appealing to the foreman at all.

5. The cost of material can be easily adjusted to suit varying markets.

6. The dead expenses of the shop can be strictly watched and the method of charging these admit of their being easily adjusted to suit the varying conditions of work in the shop.

7. The manager can be kept in touch with the actual cost of all castings made, together with the fluctuations in consumption of all material.

8. The foreman is enabled to keep a closer supervision over the time taken by his men in making castings because he is notified at once of any increase or decrease in cost.

9. The manager, without consulting the foreman, can see for himself how each order and, if necessary, how each casting is progressing. He is not dependent on the foreman for this information.

10. It is very useful in preventing the small castings for a large order being overlooked. Further, if this system is worked properly, the bad castings account is reduced to a minimum.

In conclusion, although the system is not perfect, yet the results obtained by actual working will more than repay any extra expense a foundry may be put to in introducing it. The actual cost of each casting is obtained, and, after all, this is the aim of all foundry cost systems.

THE MECHANICAL DESIGN OF BALL BEARINGS AND ROLLER BEARINGS.

By W. S. Rogers.

No one will dispute the interest of Mr. Rogers' subject nor his close acquaintance with it. The frank vigor of his manner will invite reply, to which we will be glad to afford opportunity, and he to give attention.—THE EDITORS.

SOME years ago I sat beside a bright college graduate in an audience listening to the discourse of a learned professor, when the graduate turned in disgust and said to me, "The old fox is simply repeating a thesis prepared by our class four years ago."

This illustrates about what was listened to in regard to ball and roller bearings at an important public meeting not many months ago—simply a vague phonographic reproduction of what others had observed or theorized upon; an excellent advertising opportunity taken advantage of—nothing more or less.

The first important thing to know about ball bearings or roller bearings is the material to be chosen. This question can only be decided after one knows where the bearing is to be used, the revolutions per minute, the maximum load, whether the load is constant or intermittent, and the care the bearing will receive in service.

The balls should be of the best quality in all cases. In selecting them the reputation of the ball maker is the only guide, as the largest manufacturer does not always make the best balls, neither is the highest-priced ball always the best. I have found from experience that hot-forged balls are the strongest, provided the maker has used the best grade of steel for the purpose. The honesty of the ball maker must be depended upon for this.

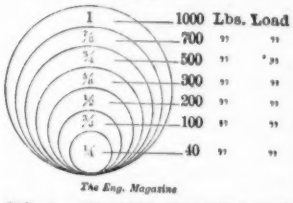


FIG. 1. GRAPHIC FORMULA FOR DIAMETERS AND LOADS.

The balls should be accurate. This the user can determine by measuring them for himself. Knowing that perfect accuracy cannot always be obtained. I have always used the formula shown at the left.

The material for the housings, or shells, sleeves, rings, races, and cones, as they may be called (for the nomenclature of ball or roller

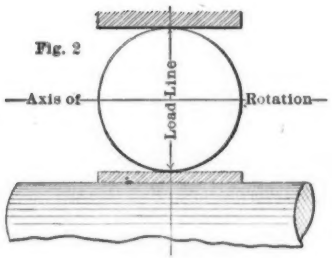


FIG. 2. RADIAL BEARING.

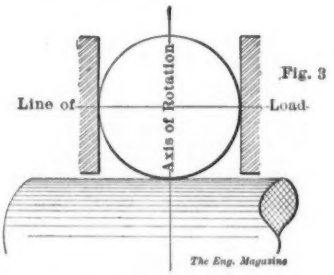


FIG. 3. THRUST BEARING.

bearings has no standards) must be determined by the conditions. Jessop's tool steel may be suitable in one condition, uncalled for in another, and totally unfit for the duty in still other conditions, and the same may be said of every known brand of steel. Practical knowledge of past performances is the only safe guide. Laboratory trials under refined atmosphere prove very, very little.

Assuming, then, that we have the best of materials obtainable for ball bearings, the question is, what is the best form of bearing? But before going into the problem, let us see what the ball has to do in the various types of bearings.

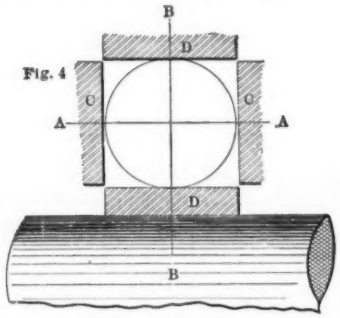


FIG. 4.

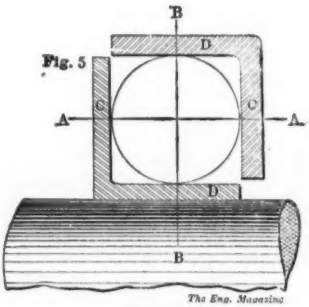


FIG. 5.

There are but two original purposes of bearings, consequently there are but two original types. One type serves for carrying the load directly upon and at right angles to the shaft or axle. This is termed a "radial" bearing. The other type takes the load of the shaft or axle endwise, or parallel to it, and is termed a "thrust" bearing.

Figure 2 shows a radial bearing carrying a load upon the shaft. It is plain to see that the axis of rotation of the ball is parallel to the

shaft and at right angles to the direction of load and resistance. With proper design and good materials, such a bearing will last a long time and save friction.

Figure 3 illustrates the simplest form of thrust bearing, in which we note that the axis of rotation of the ball is at a right angle to the shaft and parallel to the direction of load and resistance.

Thus, we see that the natural ball actions in the two fundamental types of ball bearings are in direct conflict with each other, and that it is contrary to the established laws of mechanics for a ball to have more than one axis of rotation at the same time without adding a friction and resistance of its own which eventually destroys itself as is shown in Figure 4.

Here we have the radial bearing with its rotation of axis A.A. used in combination with the thrust bearing having its rotation of axis B.B. One ball used to perform two functions diametrically opposed. Simply impossible and absurd on the face of it. The result is that the ball wears out of round, cuts grooves in the contact surfaces, and eventually crumbles away or breaks, ultimately destroying the entire bearing. But this is not bad enough and we have another invention shown in Figure 5.

Here we have the opposing plates of load and resistance joined together. Not satisfied with trying to make the ball turn two ways at once, the two resisting plates are united to prevent their eliminating the error existing in rolling contact, and compelling the ball to grind itself and the plates away faster. A modification of this type is found in Figure 6, but still possessing all its evil features.

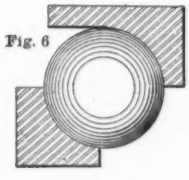


FIG. 6.

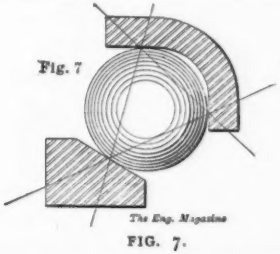


FIG. 7.

The good point which this type has to recommend it is that it can be "adjusted" and the wear taken up, but as we only know the time for adjusting has arrived when the bearing has crumbled away, the recommendation in its favor possesses little value.

The next modification of the inventor in his efforts to make a sphere rotate on two axes at the same time is found in Figure 7.

Here we have the three-point bearing. It is adjustable and the designer has eliminated one rubbing surface and "it spins like a top." But he has forgotten or else does not know that the top has but one axis of rotation and that when he removed one contact surface he left the resistance to be distributed between the other three points.

FIG. 8.

Then we have another effort in the attempt to make two conflicting laws into one illustrated in Figure 8. This form is not new; was developed over twenty-two years ago, but has become fashionable in the past two years. For use as a bearing to carry a radial load only, this type is all right and will last indefinitely if properly lubricated and cared for; but its advocates are forcing it into use both as a radial and thrust bearing, much to the sorrow and expense of the buyers and users, who assume that the sellers of an article are experienced in all points relating to their business.

Some years ago a form of thrust bearing illustrated by Figure 9 was brought before the machinery world and great things promised for it, but it quickly proved worthless, although I very much doubt if the mechanical reasons for its failure are yet clear to those most interested.

As the figure shows at once, it was of the four-point contact form, one grooved collar being tight upon the shaft and free from contact with the pulley, the other collar being free from the shaft and tight in the pulley; but it was the same effort to make a ball go in two axial directions at once. This form of bearing is good for thrust purposes only, and at very low speed has been successfully used for many years, its only error being in the angles of contact of ninety degrees.

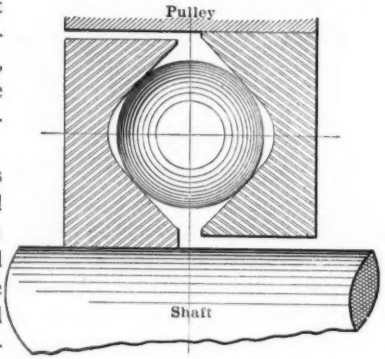


FIG. 9.

Forty years ago the forms of ball bearings were developed and used as shown in Figures 1 and 2. During that period and up to the present time there have been about eleven hundred "patents" taken out by inventors upon the same devices, but

disguised by varied curves and angles with meaningless descriptions.

The theoretic and practical radial ball bearing is seen in Figure 10. The misfortune shown in Figure 9 resembles it somewhat at first glance, but they are in widely different classes.

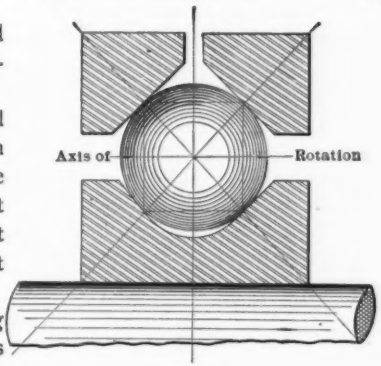


FIG. 10.

In this type of ball bearing the ball touches the raceways and spool at four points, thus forming a square of resistance through its axis of rotation and the rolling motion of the ball is uniform—equal to that of a roller. This design of bearing eliminates more friction than any other and is the most expensive to make owing to the great accuracy required in grinding the contact angles so they may be true with the bore and the outside diameters as well as true with the sides.

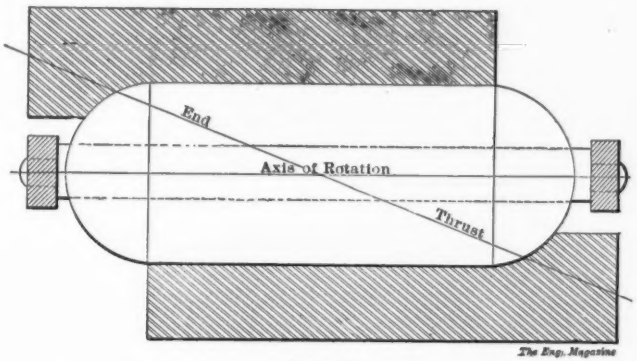


FIG. 11.

It will carry as much load as a two-point bearing if true and accurate. For this reason the two-point is more popular, as it is much easier to make and at a better profit. This type of bearing can be made adjustable but should not be used for carrying end-thrust loads.

The most surprising design of a combination radial and thrust bearing ever inflicted upon a bewildered mechanical community is that shown in Figure 11.

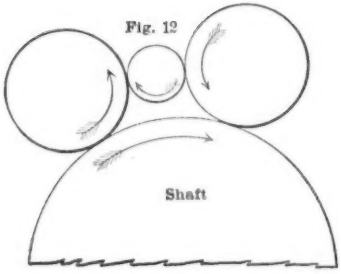


FIG. 12.

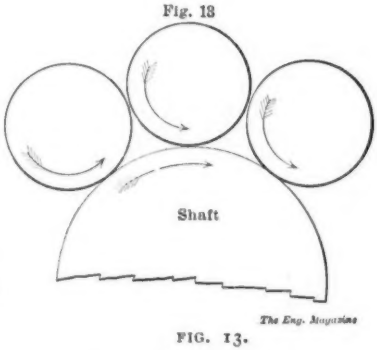


FIG. 13.

The rollers have round ends, but are sometimes made with a sharp bevel and are held in a cage or retainer. The desire of the rollers under duty is to twist themselves in two, and failing in this they distort the cage and quickly destroy everything. Innocent automobile buyers have suffered greatly from this type owing to its cheapness.

Figure 12 illustrates another form of design of both ball and roller bearings that inventors and promoters have spasmodically tried to introduce for the past thirty years. A small ball or roller is interposed between the large ones carrying the load, with the assumed idea that the smaller ball eliminates the friction of the surfaces of the larger ones produced by their rolling in opposite directions. The fact of the matter is the balls or rollers are never in contact when under load in the design, as shown in Figure 13. The

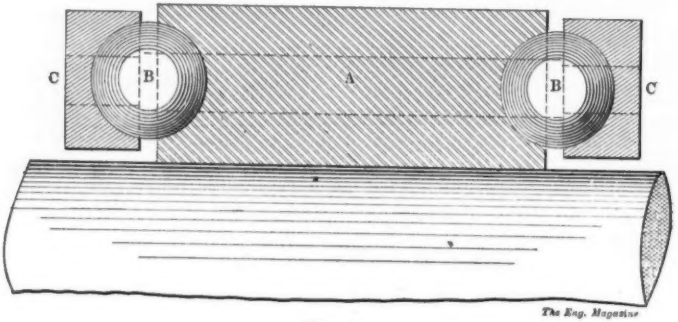


FIG. 14.

weak point in the type shown in Figure 12 is the high speed of the smaller ball or roller which rapidly destroys its usefulness.

Sometimes the question is asked how much friction is caused by a retainer or cage used to guide and keep the balls or rollers in place, and it can be answered by saying that such friction is infinitesimal and not worth taking into account. The chief thing to consider is the elimination of unnatural friction and work for the balls or rollers.

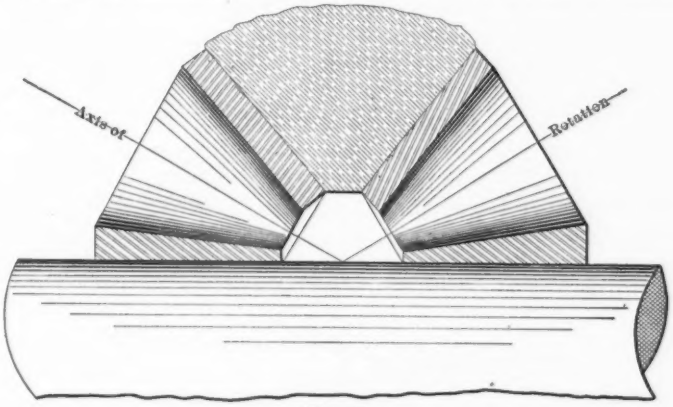


FIG. 15.

Figure 14 shows another freak in the form of a "ball end-thrust roller bearing." When first exploited it was as a bearing to take the end thrust as well as direct load. The proposition was too ridiculous for the mechanical public and the "end-thrust" part of it is in the dim past. A is the roller; B.B. are balls socketed into either the roller or the cage end, C—or both, as fancy pleases. The balls act simply as gudgeons—nothing more. Were the ends of the roller rounded or made to conform to the shape of the ball the same result would be accomplished at much less expense. Nevertheless it is a good roller bearing.

A form of bearing for carrying the direct radial load and at the same time assuming some of the end thrust is the conical roller type. The circles of rolling contact are not all true and it is not the perfect frictionless bearing many of its advocates claim; nevertheless it is a happy medium between an easy roll and a wedge, and will endure greater abuse than perhaps any other type or form. There have been many forms of this design shown in Figure 15. What is the correct pitch or angle of rotation of the rollers with reference

to the shaft is unknown, as no comparative trials have ever been made.

A roller bearing with long cylindrical rollers should be avoided always. The frequent inaccuracy in grinding the rollers so as to preserve the same diameters at the ends and in the middle prevents an even, true rolling motion under load. The tendency of one end of a roller to travel faster than the other end starts the cage or retainer to winding or twisting, and the whole fabric becomes worthless. Rollers should never be made more than 4 inches long and then only when ¾ inch in diameter or larger. Even when no cage is used this tendency of the rollers to ride out of parallel to the shaft is apparent. For this reason there should always be allowance given between the outside shell and inner sleeve of plenty of play for readjustment of the rollers unless they have come to the side of the shaft where they are free from load.

The same reasons exist for making ball bearings "easy fits" or what we might term "shaky" when assembled. The most worthless bearing made is that which is assembled by force.

The thrust bearing shown in Figure 3 is the most popular because of its ease to make. It is durable as well, notwithstanding the eventual loss of spherical shape of the balls on account of the effort exercised by the two opposing collars to drive the balls on two different rotating axes at the same time. In addition to the motion shown in the illustration the ball is compelled to travel in a circle at right angles to its axis. This causes slight wearing friction. At speeds over 400 revolutions per minute there is also a tendency on the part of the balls to fly outward and cut their way out of the cage or retainer. This they eventually do, and to overcome this the bearing shown in Figure 16 is used. It is simply a two-point bearing, the balls rolling in grooves. They may be held in a retainer, or not; it is immaterial. The cage is simply for convenience in handling. This type of bearing may also be made with but one grooved collar. When the two grooves are used care must be taken to see that the ball races are concentric with each other and with the inner diameters when they are to be used upon a shaft.

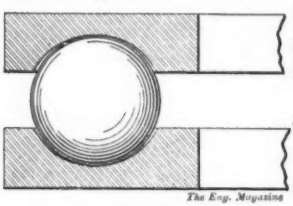


FIG. 16.

Another type of end thrust sometimes called a four-point bearing has been shown in Figure 9. This is rather an expensive bearing unless used at slow speed and for heavy loads.

The correct thrust bearing in point of durability at extremely high speed, and as a load carrier, is seen in Figure 17. This is the true, rolling four-point thrust bearing—hard to make—but when once made, accurately and of good material, it is a "beauty and joy forever." Few are in demand as the first cost is too great for the weight of the bearing commercially.

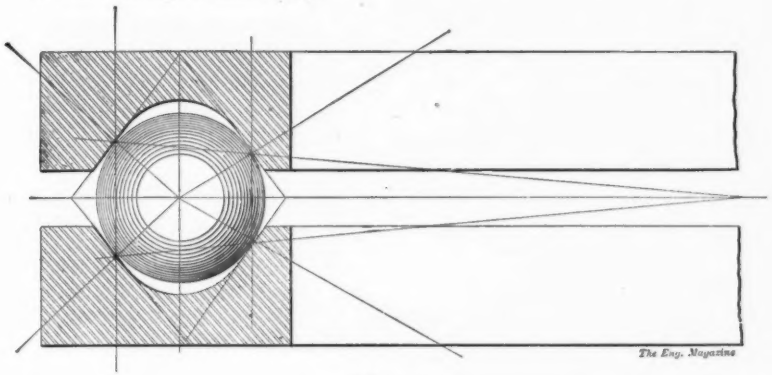


FIG. 17.

Bearings of this form have been taking end-thrust load and running 12,000 revolutions per minute for the past seven years, every day in the year. They are also practically noiseless if the angles are correct. Care must be observed in making them to have the angles of contact a true rolling surface with the cross section of a cone produced by correct included angles from the center of the shaft. These angles must also be concentric with each other, and with the inner diameter of the collars as well. For high rotative speed it is essential that the bearing be as nearly balanced as possible.

Figure 18 illustrates what engineers would term a "make-shift" thrust roller bearing, suitable only in contracted and narrow spaces where the load is greater than a ball bearing of the same size would sustain.

One can readily see that it is not right; the circular motion of the cage or carrier of the rollers is shown by the arrow "a." The determination of the rollers is to travel tangent to "a" as shown by the arrow "b," causing constant slipping and resistance. But it is about 25 per cent better than none whatever, and works quite a long time at slow speed and has been before the public for about thirty years. I am often asked if this type of bearing cannot be made in halves, and my answer is, "No"—because the action of the rollers when passing over the joints of the hardened steel collars is the same

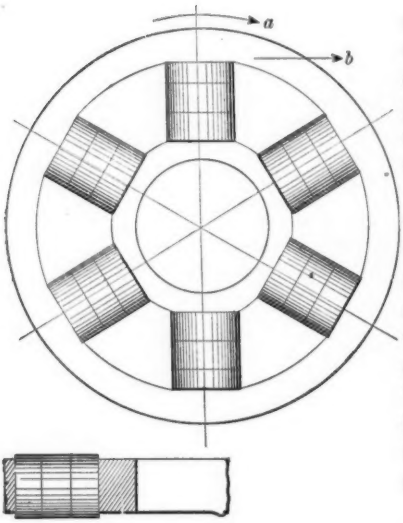


FIG. 18.

as that of heavy car trucks upon railroad track joints—only worse, as the steel collar joints are very brittle and the chips soon cause the rollers to clog and slide.

The best form of end-thrust roller bearing is that shown in Figure 19. To be perfect in every way there should be an additional end-thrust bearing on the outer end of each conical roller. This makes a very expensive bearing when completed, but it will withstand great loads at very high rotative speed.

In this article I have said but little concerning the cages, retainers, or carriers for holding the balls or rollers in place, for the reason that their name is legion and after all is said and done there has been nothing new developed or patented in the past twenty years that had not been anticipated by mechanics and inventors in years gone by. Recent court decisions have proven that patents obtained within the past eighteen years are, to all commercial intents, worthless.

I am asked, how close a fit should the collars of a thrust bearing be to the shaft, and I say, 0.01 inch, not less.

The man who advocates less knows nothing of expansion or contraction, and is close kin to the crank that spends hours of valuable time every day trying to part his hair absolutely in the middle.

I am often asked, "How long will a bearing last?" It all depends upon where it is used, how it is used, its design, and who made it.

The same question and answer applies equally as well to emery wheels, steel rails and beer. The biggest brewery does not always make the best beer.

Another query oft repeated is, "What patents are there that control the manufacture of thrust bearings?" There are no "controlling" patents of any kind whatever, and it is either rankest idiocy or else blackmail for any one to claim or threaten such things. The

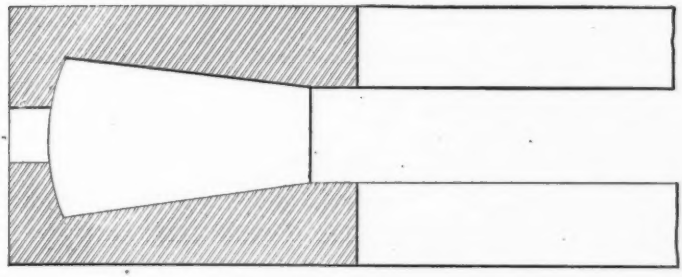


FIG. 19.

original ball thrust bearing with balls held in a cage between two hard, flat surfaces was granted in 1873. The type shown in Figure 17 was patented first in the 70's and has been duplicated since several times owing to inefficiency of American patent-office methods.

Nearly seventeen hundred patents have been granted since 1833 upon roller and ball bearings. The original one was an application to a grindstone. As I have stated, the mass of existing patents today are not worth the paper they are printed upon except as "promoters assets." Nevertheless the industry is but an infant, growing, and yet in its knickerbockers.

THE INDUSTRIAL RELATIONS OF THE AMERICAN CEMENT INDUSTRY.

By Edwin C. Eckel.

Mr. Eckel is the specialist of the United States Geological survey in the cement industry, and his clear sight and firm grasp of the entire subject are in striking and valuable contrast to the inaccurate and misleading reports current in the popular press. A very interesting feature of his review, considering the growing importance of reinforced concrete in engineering construction, is the close parallel Mr. Eckel establishes between the cement and the steel industries in the United States.—THE EDITORS.

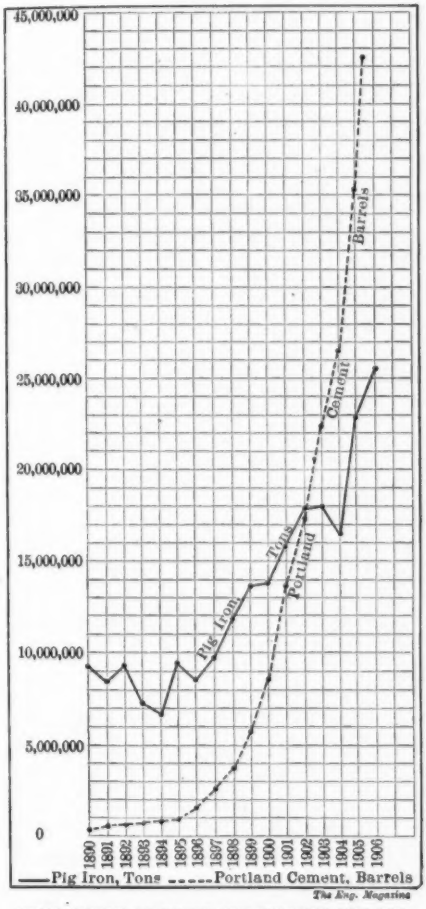
LESS than a year ago, in discussing the surprising progress which the American portland-cement industry has exhibited during the quarter-century of its history, statistics showing this growth were presented in considerable detail.* There is no necessity, therefore, for recurring to that phase of the subject in the present paper, in which attention will be directed rather toward certain more general industrial relations which appear to be in process of development. At the present day the cement industry is still in a rapidly expanding condition; and, furthermore, is intensely individualistic. No check to its progress and no symptoms of "consolidation of interests" have yet appeared; and it is of interest to determine, so far as is possible, what are the probabilities that the future of the industry will continue to be marked by similar conditions.

THE GROWTH CURVES FOR IRON AND CEMENT.

Before taking up matters which relate specifically to the cement industry, it will be of interest to compare its growth with that of a nearly related industry—the manufacture of pig iron. This is done graphically in Figure 1, which shows what may be called the "growth-curves" of the two industries for the period 1890-1906 inclusive. The figures on which this diagram is based are official except for the present year, where estimated values are given.

The diagram is, of course, distorted to the extent that while the pig-iron production is given in tons (of 2,240 pounds) the cement output is stated in barrels (of 384 pounds). But this distortion does

* THE ENGINEERING MAGAZINE, February, 1906.



COMPARISON OF PORTLAND-CEMENT AND PIG-IRON PRODUCTION, 1890-1906.

Based on official figures, except for 1906 which is estimated.

not affect the value of the diagram when used for its present purpose—a comparison of the *form* of the two growth-curves.

On examination it will be seen that the cement curve rises steadily, at an increasing ratio each year, showing no downward flexures or relapses. This is the normal form for the growth curve of a young and rapidly expanding industry. The iron curve, on the other hand, though showing a decided gain for the period covered, also shows at intervals depression flexures, typical of a mature industry, whose annual output must now depend on the general financial and industrial condition of the country.

The cement output, as yet, has not suffered markedly from financial depressions. Prices have fallen off in poor years, it is true, but the annual output has always increased. The rise in yearly output from 1885 to 1906 has not only been continuous, but has even shown a tendency to increase its *rate* of increase. Of course such a condition of the industry can not be expected to continue indefinitely. Within a few years we must expect to see the rate of increase lowered, and finally, in some period of business depression, some year will show a lower output than the preceding year. This

will mark the end of the youth of the cement industry, and the beginning of its period of maturity. Though the present condition of the industry is as prosperous as might be desired, it is possible that the change in rate of growth may be quite near at hand. New construction in 1906, and plans for 1907, will provide a great increase in mill capacity. If the succeeding years are generally good, this increase will be taken up without difficulty; but a general financial depression in 1908 would probably result in a temporary check to the cement industry. So far as can be estimated now, the plants which will be in operation before the end of 1907 will turn out cement at the rate of 50,000,000 barrels per annum, and it is doubtful whether such an output could be absorbed if the United States were not generally prosperous.

Localization of the Industry.

The cement industry exhibits the same tendency toward geographic centralization, though in a less degree, that has given Pittsburg its pre-eminence as an iron producer. In the case of the cement industry the concentration of plants is in the so-called Lehigh district of Pennsylvania, with its New Jersey continuation. Here, eighteen plants made over 17,000,000 barrels, or almost exactly half of all the cement produced in the United States in 1905. The Lehigh district was the point where American portland-cement manufacture was first undertaken: and it owes its continued pre-eminence to good raw materials, good labor, fairly cheap fuel, and excellent transportation facilities to large Eastern markets.

Taking a general view of the matter, the present geographic distribution of the cement industry is well shown in the following table. The term "East," as here used, includes plants in Pennsylvania, New York, and New Jersey, none being located in New England. The "Central" plants are those in Ohio, Indiana, Illinois, Michigan, and Missouri. Under "West" are included Kansas, Colorado, South Dakota, and Utah. On the Pacific coast are the three active California plants. The "South" includes Virginia, West Virginia, Georgia, Alabama, Arkansas, Texas, and Kentucky.

Geographic Distribution of Portland-Cement Industry in 1905.

	East.	Central.	West.	Pacific coast.	South.
Number of plants operating	39	32	7	3	7
Output in barrels, 1905	19,589,675	10,723,802	2,470,349	1,225,429	1,237,557
Percentage of total output	55.6	30.4	7.0	3.5	3.5

This amount of concentration can hardly be expected to last long. Within a few years the Western, Pacific, and Southern areas will be supplied in much better fashion than they are at present. A powerful impetus in this direction was given by the destruction of San Francisco, which called to the attention of investors in the Eastern United States and in England the fact that the Pacific Coast States could normally absorb much more cement than was made on the coast. In the face of the San Francisco disaster the few western plants in operation were not capable of making much impression on the immense and instant demand.

In the South, too, there is an excess of demand over supply; and even the plants now under construction in the southern States will hardly reduce this excess. It is probable that the States south of the Potomac and Ohio and east of the Mississippi could use, at profitable prices, about five time as much cement as is now made in that district; and for a long time this field will be one of the most profitable ones for the cement manufacturer. Fuel is cheap, raw materials are abundant and good, and the demand is steadily increasing.

The Difficulty of Monopoly.

Perhaps the most marked feature of American economic history during the past decade has been the manner in which industry after industry has become consolidated in control, so as to approach more or less closely to monopoly. This has been particularly well-marked in the iron and steel industries, and it is worth considering how far a similar evolution is likely to affect the cement industry. At present the cement industry is the most individualistic of the larger branches of manufacture. No "trust" or even approach to a monopoly is now in existence, newspaper statements to the contrary notwithstanding; and in my opinion the nature of the cement industry renders it impossible that any large degree of consolidation of interest can take place.

When the history of both successful and unsuccessful "trusts" is examined, it will be seen that the only way in which a permanent monopoly can be secured and retained by any consolidation is by the control of the supply of raw material. Any trust which disregards this fact, and is content with simply consolidating all or most of the existing manufacturing plants, is in line for disaster. For, supplies of raw materials being still available for outsiders, the first advance in prices will be the signal for the erection of competitive plants. If, on the other hand, the raw materials can be cornered, there is no possibility of competition. This fact, though disregarded a decade

ago, is now generally borne in mind. The strong position of the United States Steel Corporation, for example, is not due to its control of blast furnaces and steel plants—for these could be readily duplicated—but to the fact that it controls three-fourths or more of the known reserves of iron ores in the Lake Superior district; and is therefore currently believed to have almost a monopoly of the good ores of the United States. So long as Lake Superior ores are deemed necessary by furnacemen in general, it may be safely said that the Steel Corporation is in no real danger of serious competition. Current belief is, in this case, probably far from correct, a matter which will be discussed in a later number of this Magazine. The fact that the belief is erroneous does not affect the argument; for the next best thing to having a monopoly is to be able to persuade your prospective competitors that you have one.

The bearing of these facts upon the future of the cement industry is obvious enough. If there is any possibility that one large cement corporation can acquire control of most of the available deposits of cement material in the United States, it will be possible to form a real American "Cement Trust," to defy competition, and to raise prices to an unwarranted level. If, on the other hand, it is impossible to execute such a corner in cement rock, it will be impossible for any consolidation to raise prices permanently above the normal.

On considering the matter, it will be seen that only one answer is possible. It is, I think, within safe limits to say that over 20 per cent of the entire area of the United States is underlain by raw materials out of which cement could be made, if prices were forced high enough. The Standard Oil Company, the United States Steel Corporation, and the United States Government could not, by combining their financial resources, hope to acquire control of any large fraction of this immense reserve of raw material.

Since the supply of limestone and clay can not be cornered, and since no essential parts of the processes of manufacture are covered by patents, it is reasonable to believe that no cement combination can succeed in raising prices to unfair rates. It is hardly necessary to add that, despite frequent newspaper statements to the contrary, there is nothing in existence at present even remotely approaching a cement trust. The trouble is rather the other way. The prosperity of the past few years, with reports of enormous profits earned by existing companies, have led to the building of many new cement plants. A fair proportion of these are either too small, badly located, faulty in design, or badly managed; and with the first general business

depression and the commencement of falling prices, such plants will necessarily become a danger to the entire industry. The condition at present is therefore marked by excess, rather than lack, of competition.

At present, indeed, the only limitation on unprofitable increase in the number of cement plants arises from the fact that even the smallest possible units are expensive to construct and operate. In any district where competition could be expected, for example, it would usually be inadvisable to build a smaller than a four-kiln plant. This would have an output of 1,500 barrels or more per day; but it would cost $350,000 to $450,000 to build, and would require a working capital of $125,000 to $175,000 in addition. It can therefore be readily seen that the cement industry is not one in which individuals or small firms can find much opening.

Normal Growth and Concentration.

While, as above stated, it is impossible that the cement industry should ever become a monopoly, based on control of deposits of raw materials, another phase of the subject requires consideration. The cement industry is essentially one in which brains and money are far more important than raw materials, and consequently cement plants with intelligently directed capital will rapidly increase in size while poorer or ill-managed plants either remain stationary or expand very slowly. This of itself operates to cause a gradual concentration of interest; the stronger plants grow, at the expense of the weaker. The extent to which this development has already taken place is indicated in the following extract from an official report which I recently made on the cement industry in the United States during 1905:

> "The eighty-eight plants in existence in 1905 are owned by seventy-eight companies, and several of these nominally independent companies are closely connected in ownership.
>
> "Of these seventy-eight companies, fifteen produced over two-thirds of the entire American portland-cement output. Seven of these showed an annual output of over one million barrels each, and these seven together produced somewhat over half of the entire output of the country. To place the matter in a comparative form, the five largest companies together produced about the same percentage of the American cement output that the United States Steel Corporation does of the American output of pig iron. The cement industry is at present, therefore, in a more concentrated condition than was the iron and steel industry at the date of formation of the Steel Corporation, but further concentration, to such a point as to bring about unfairly high prices, does not seem practicable."

Most of the larger companies, which now produce the bulk of the American cement output, were originally concerns of only average size. Their growth has taken place in a natural manner, not by the

absorption of competitive plants, but by using part of the profits of the business to increase the size of the original plant. In a strongly held and well-managed company, this course of action is possible. In a company less strongly owned or less intelligently directed, the tendency is always to sacrifice the prospects of ultimate success to the certainty of immediate returns. A company owned by a number of small stockholders can rarely withstand the pressure in favor of paying out all the profits as dividends.

The larger company growing by accretion has also a certain advantage in the matter of advertising its products. When the Atlas Portland Cement Co., for example, established a new plant at Hannibal, Mo., there was no difficulty in introducing the cement from the new plant, for it sold, of course, under the already well-known "Atlas" brand. The other large and growing companies, such as Lehigh, Universal, etc., have adopted the same policy—so that the product of any new plant which they may build has behind it the accumulated prestige of all the older plants.

Capitalization and Promotion.

From two more serious evils—over-capitalization and fraudulent promoting—the American cement industry has been fairly free, though there are signs that this happy immunity is not destined to continue. So far as the first is concerned, figures obtained unofficially from various sources would indicate that the total authorized capitalization of all the American portland-cement plants operating in 1906 falls within the limits of $110,000,000 and $125,000,000. This estimate takes no account of outstanding bond issues, but on the other hand gives no credit for stock authorized but not issued. On the whole, therefore, it can be accepted as representing very fairly the total capitalization of the entire industry. This capitalization can not be considered excessive, in view of the fact that it would probably cost some $75,000,000 to $85,000,000 to replace the plants now in existence.

Considering the matter broadly, it can be said that in the East, including the plants from New York to Illinois, there has been little attempt at over-capitalization or fraud. Most of these older companies were organized by persons familiar with the business, and the necessary capital was secured more or less privately, with little attempt to raise money by selling stock to the public. Michigan, apparently, was the first State in which the promoter found an opportunity to display his peculiar talents; and for a number of years that State was dotted with prospective cement plants. Most of these

flotations were capitalized excessively, owing to the fact that for the first time in the history of the industry the stock was being sold to the public. Advertisements of stock for sale at ten cents or a dollar per share, with promises of 20 to 60 per cent dividends, and wonderful miscalculations as to operating costs, filled the papers of the Middle West during this period.

After the Michigan boom had collapsed, leaving behind it a few good plants, a few poor ones, and a much larger number which had never come into existence other than in the prospectus, the promoter was for a few years not much in evidence. His reappearance took place when the Iola plant proved the profits in making cement in the natural-gas belt in Kansas, and for the past few years we have been steadily and painfully impressed with the wonderful profits awaiting the erection of cement plants in the states west of the Mississippi, notably Kansas and Iowa.

THE STEEL CORPORATION AND THE CEMENT INDUSTRY.

Curiously enough, the most important of the so-called American "trusts" is largely interested, as a side line, in the manufacture of portland cement, ranking well up among the half-dozen larger cement producers.

The relation of the United States Steel Corporation to the American cement industry can fortunately be discussed freely, without making use of the statistics gathered by the Geological Survey, which are obtained under promise of secrecy as to individual production. This condition is due to the fact that the Steel Corporation, with commendable frankness, publishes very complete details as to its operations in its annual reports; and these annual reports have recently been supplemented by an interesting statement on the subject of its cement-manufacturing interests.

Since May, 1900, the Steel Corporation has manufactured portland cement, and the amount of its output by years, together with the relation of this output to the total American production, is shown in the following table:

Year.	Total American output, bbls.	Produced by U. S. Steel Corp.	Percentage of total output.
1900	8,482,020	32,443	0.38
1901	12,711,225	164,316	1.29
1902	17,230,644	318,710	1.85
1903	22,342,973	462,930	2.08
1904	26,505,881	473,294	1.78
1905	35,246,812	1,735,343	4.92
1906	42,000,000 †	2,200,000 *	5.24

†Estimated by E. C. Eckel. *Estimated by U. S. Steel Corporation.

From these figures it will be seen that the Steel Corporation is growing, not only in absolute annual output, but also in the relative importance of its output to the industry at large. It might further be added that it is growing even faster than most of the other large companies, so that its rank as a producer has gradually improved. It is therefore to be reckoned with as a serious element in the portland-cement industry of the future.

At the cement plants operated by the Steel Corporation, the raw materials used are slag and limestone. Since the slag is a by-product, the cost of its raw materials, per barrel of finished cement, should be considerably less than at plants whose entire supply of raw material must be quarried. Furthermore, there are certain technologic advantages connected with the use of slag, which should tend to lessen the fuel cost per barrel of cement. The total advantage of using a slag-limestone mixture, as against a mixture of limestone and shale, might amount to 5 to 10 cents per barrel of cement: and if this advantage is realized in practice at the various Steel Corporation plants, it is obvious that they will be serious competitors to any ordinary plants within their sphere of influence.

EDITORIAL COMMENT

THE President's message on Panama is in many respects a most delightful document—untrammeled by precedent, exuberant in its joyous flow, overbrimming with satisfaction in everything and everyone connected with the Canal work. Its confidence will carry mastering conviction to those who were already convinced. Its picture of the perfect state into which no scandal nor mistake has entered, (and only one mosquito), will pass pleasantly before the tolerant eyes of those who know that all human undertakings are more or less marred by faults of reason and sins of will, and that vast engineering enterprises (in the tropics, particularly) can scarcely be more than compromises with error and accident, in which the Evil One is substantially certain to score an occasional point. Its herding of all critics into the traitor class—or into what has come to be known irreverently as the Order of Sapphira, or the Ananias Club—will deter no one who purposes to follow the Canal work carefully, conscientiously, and sanely, striving ceaselessly and fearlessly *not* simply to find everything good, but to decide and to help his country to decide between the good and the evil.

In short, the message will leave things much as it found them. We do not say it ill-naturedly, but it might have been written before the President had seen Panama, almost as well as after; for it is written from his heart, which was already so wedded to the convictions expressed that nothing could have divorced them.

Engineering work—successful, triumphant, constructive work—is not without its enthusiasms, but they are not of this kind. It goes forward confidently, but very watchfully; with little shouting, but much heart-searching; accepting no surface appearances as conclusive, but boring deep and testing hard.

The habit of intimate inquiry, stopping nowhere short of the absolute fact, is innate in the brain and conscience of the engineer and is developed to its highest capability by his training. He is neither dazzled by the glittering prospectus nor deterred by the big stick. He has had his part to play in the soul-searching investigations after which the Panama enterprise was adopted and placed upon its present sure basis as to type and plans. He has his part to play on the Isthmus now, and we are well satisfied that, as represented by the engineering force there, he is doing it admirably under very difficult conditions. He has, however, yet a further part to play in the continual scrutiny of the progress of the undertaking and of every circumstance surrounding it. He may be harder to satisfy than the President, but he will be no less patriotic. And his criticism will be neither hastened nor delayed by any attempt to forestall its purport or discredit its effect. More than this: it will be henceforth, as it has been heretofore, the criticism by which the world and the future will test the completed work.

The President must realize, on review of the history of the Canal undertaking, that every worthy step so far made has been the result of the fullest and freest public discussion, and that in almost every instance the superficial optimist, eager to silence all opposition and rush on with his self-satisfactory plan, has proved to be wrong. In almost every instance, the hard, cold conclusions of the engineer, running often counter to the popular feeling, have been finally accepted as right. And the safety of the enterprise in the future demands the continuance of the same unham-

pered, unmuzzled criticism to which it has all along been subject.

We believe that the affairs of the Commission have been as well and as wisely administered as the inherent difficulties of Governmental bodies permit. We believe that the work on the Isthmus has been pushed as far and as fast as it could be under a commission controlled by Administrative and departmental ideals. We endorse enthusiastically the Administration's plan for turning over the further prosecution of the work to a practical contracting organization, to be carried forward under sound business principles. The sooner and the more completely this can be accomplished, under an honest and wholesome contract, the safer the outcome will be. We have no sympathy for the sensationalist nor the scandal monger; but we feel that at the present stage—and perhaps always—the enterprise has more to fear from the optimist than from the critic.

* * *

THE spirit of retrospection which naturally awakens with the end of the old year and the beginning of the new, seems to find less place than usual this season. The rush of activity is so overwhelming that the thoughts and eyes of the country are all ahead; its energies are wholly consumed in keeping up with the business of the hour. It is content to cope with the present, and has little time or care for the survey of the past or the forecast of the future. An occasional voice asks: "Will it last? How long will it last?" But the query is almost lost in the universal hum of prosperous activity.

The signs seem to indicate that the conditions are more than those simply of an ordinary, rhythmic cycle of prosperity such as we have experienced in the past. They appear to belong to an epoch of permanent change in level in industrial conditions. This does not mean that the wave will remain always at its crest, but that it towers so high partly because the whole flood of the industrial sea has risen with reference to our old bench marks, and its mean level, even at the ebb of the wave, will be on a higher plane.

It was pointed out in these pages long ago that just such a phenomenon would result from the enormous increase in the output of gold. In our own country there is, of course, coincidentally, a phenomenal outpouring of natural wealth in the form of agricultural and mineral products. The situation is not without precedent in the history of the world, but it is quite without parallel. There have been large and sudden additions to the world's store of precious metal; but never before have there been simultanously such opportunities--temptations—demands—for the employment of money in productive enterprises. The present total of undertakings under way, designed either to be directly productive or to increase vastly the economy of distribution of products, is almost overwhelming. There are even now some ready to pray that nothing more be added to our prosperity.

The conditions are dangerous only to those who may be tempted to extravagance. As Mr. Carpenter points out in the leading article in this number, wisdom and prudence will seize this time as the very best for introducing such sure and lasting economies as will make their possessors secure of a competence and a profitable business, however lean may be some of the years to come. Permanent success in a manufacturing business, as Mr. Carpenter shows, depends on skilful internal adjustment of the various forces—physical, mechanical, and human—operating in the works, and not upon chance or fortune of outside "pull" or policy. There is safety and comfort in the realization, for the inside forces are exactly those which the manager can control. The principles of "Profit-Making Management" will be one of our strong themes for months to come. The application will lie with the individual manager, and the reward will belong all to him who succeeds.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE ART OF CUTTING METALS.

A REMARKABLE REVIEW OF EXPERIMENTAL WORK WHICH HAS LED TO A REVOLUTION IN MACHINE-SHOP PRACTICE.

Fred W. Taylor—American Society of Mechanical Engineers.

SINCE the beginning of the present century, there has been a practical revolution in machine-shop practice. This has been caused most directly by the introduction of the high-speed cutting tools, but has also been largely influenced by the systematic study of shop conditions, and the intelligent application of the information thus obtained to the management of works. The man who has taken the leading part in this revolution, Mr. Fred W. Taylor, has been president of the American Society of Mechanical Engineers for the past year, and in his address recently delivered before that Society, he gives a remarkable history of his work for the last twenty-six years and reviews the practical lessons which have been learned therefrom.

This address, which is in reality a treatise on metal cutting and machine-shop management, consists of two main parts, and a great many tables, curves and illustrations on folders. The first part gives a history of the experiments which have been made by Mr. Taylor and his associates, together with the general conclusions drawn from their work, while the second part is more technical in character and goes into much more detail. There are altogether about 250 pages of text, and 140 drawings and tables. This paper should be carefully studied by every machine-shop man, tool maker and works manager, and the few extracts which can be reproduced here will only give an idea of the scope and value of the address as a whole.

"The experiments described in this paper were undertaken to obtain a part of the information necessary to establish in a machine shop our system of management, the central idea of which is: (A) To give each workman each day in advance a definite task, with detailed written instructions, and an exact time allowance for each element of the work. (B) To pay extraordinarily high wages to those who perform their tasks in the allotted time, and ordinary wages to those who take more than their time allowance. There are three questions which must be answered each day in every machine shop by every machinist who is running a metal cutting machine, such as a lathe, planer, drill press, milling machine, etc., namely:

"*a.* What tool shall I use?

"*b.* What cutting speed shall I use?

"*c.* What feed shall I use?

"Our investigations, which were started 26 years ago with the definite purpose of finding the true answers to these questions under all the varying conditions of machine shop practice, have been carried on up to the present time with this as the main object still in view.

"The writer will confine himself almost exclusively to an attempted solution of this problem as it affects 'roughing work;' *i. e.*, the preparation of the forgings or casting for the final finishing cut, which is taken only in those cases where great accuracy or high finish is called for. Fine finishing cuts will not be dealt with. Our principal object will be to describe the fundamental laws and principles which will en-

able us to do 'roughing work' in the shortest time, whether the cuts are light or heavy, whether the work is rigid or elastic and whether the machine tools are light and of small driving power, or heavy and rigid with ample driving power. In other words, our problem is to take the work and machines as we find them in a machine shop and by properly changing the countershaft speeds, equipping the shop with tools of the best quality and shapes and then making a slide rule for each machine to enable an intelligent mechanic with the aid of these slide rules to tell each workman how to do each piece of work in the quickest time.

"It may seem strange to say that a slide rule enables a good mechanic to double the output of a machine which has been run, for example, for 10 years by a first-class machinist having exceptional knowledge of and experience with his machine and who has been using his best judgment. Yet our observation shows that, on the average, this understates the fact. To make the reason for this more clear it should be understood that the man with the aid of his slide rule is called upon to determine the effect which each of the 12 elements or variables given below has upon the choice of cutting speed and feed; and it will be evident that the mechanic, expert or mathematician does not live who, without the aid of a slide rule or its equivalent, can hold in his head these 12 variables and measure their joint effect upon the problem. These 12 elements or variables are as follows:

"*a*. The quality of the metal which is to be cut.

"*b*. The diameter of the work.

"*c*. The depth of the cut.

"*d*. The thickness of the shaving.

"*e*. The elasticity of the work and of the tool.

"*f*. The shape or contour of the cutting edge of the tool, together with its clearance and lip angles.

"*g*. The chemical composition of the steel from which the tool is made, and the heat treatment of the tool.

"*h*. Whether a copious stream of water, or other cooling medium, is used on the tool.

"*j*. The duration of the cut—*i. e.*, the time which a tool must last under pressure of the shaving without being reground.

"*k*. The pressure of the chip or shaving upon the tool.

"*l*. The changes of speed and feed possible in the lathe.

"*m*. The pulling and feeding power of the lathe.

"Broadly speaking, the problem of studying the effect of each of the above variables upon the cutting speed and of making this study practically useful may be divided into four sections, as follows:

"(A) The determination by a series of experiments of the important facts or laws connected with the art of cutting metals.

"(B) The finding of mathematical expressions for these laws which are so simple as to be suited to daily use.

"(C) The investigation of the limitations and possibilities of metal cutting machines.

"(D) The development of an instrument (a slide rule) which embodies, on the one hand, the laws of cutting metals, and on the other the possibilities and limitations of the particular lathe or planer, etc., to which it applies, and which can be used by a machinist without mathematical training to quickly indicate in each case the speed and feed which will do the work quickest and best."

The experiments were begun in the fall of 1880 in the machine shop of the Midvale Steel Company, and were encouraged and aided by Mr. William Sellers, at that time president of the company. "Our experiments were continued in the works of the Midvale Steel Company until 1889, when the writer left its employ. Since then these investigations have been carried on in various shops and at the expense of different companies. Among these we would especially acknowledge our indebtedness to the Cramp's Shipbuilding Company, Wm. Sellers & Co., the Link-Belt Engineering Company, Dodge & Day, and, more than all, to the Bethlehem Steel Company."

Mr. Taylor gives full credit to the men who have assisted him in this work, the principal ones being Mr. H. L. Gantt, who has been generally interested in the experiments for nearly 20 years, Mr. Maunsel White, who has been especially active in the metallurgical part of the investigations, Mr. Carl G. Barth, who has helped largely

in the development of the slide rule and in other mathematical work, and Mr. G. M. Sinclair.

"In carrying on this work more than 10 machines have been fitted up at various times with special driving apparatus and the other needed appliances, all machines used since 1894 having been equipped with electric drives, so as to obtain any desired cutting speed. The thoroughness with which the work has been done may perhaps be better appreciated when it is understood that we have made between 30,000 and 50,000 recorded experiments, and many others of which no record was kept. In studying these laws we have cut up into chips with our experimental tools more than 800,000 lb. of steel and iron. More than 16,000 experiments were recorded in the Bethlehem Steel Company. We estimate that up to date between $150,000 and $200,000 have been spent upon this work, and it is a very great satisfaction to feel that those whose generosity has enabled us to carry on the experiments have received ample return for their money through the increased output and the economy in running their shops which have resulted from our experiments."

During the whole course of the investigations, almost all the laws discovered have been used for the exclusive benefit of the companies furnishing the means for carrying on the experiments, but it is thought that the time has now come to give the results of the work to the engineering fraternity, in spite of the fact that this will cut off the former sources of revenue for continuing the experiments. But hopes are expressed that the money needed to complete the work may be obtained from other sources.

A chronology of the discoveries made in the course of the work is given, some of the principal ones being: that the pouring of a heavy stream of water directly upon the chip at the point where it is being removed from the steel forging by a tool, will permit an increase in cutting speed of from 30 to 40 per cent; that a greater proportional gain could be made in cutting soft metals through the use of tools made from self-hardening steels than in cutting hard metals, the gain made by the use of self-hardening tools over tempered tools in cutting soft cast iron being almost 90 per cent, whereas the gain in cutting hard steels or hard cast iron was only about 45 per cent; and, most important of all, that tools made from chromium-tungsten steels, when heated to the melting point, would do from two to four times as much work as other tools, which led to the development of the Taylor-White process of treating tools.

"While many of the results of these experiments are both interesting and valuable, we regard as of by far the greatest value that portion of our experiments and of our mathematical work which has resulted in the development of the slide rules—*i. e.*, the patient investigation and mathematical expression of the exact effect upon the cutting speed of such elements, as the shape of the cutting edge of the tool, the thickness of the shaving, the depth of the cut, the quality of the metal being cut and the duration of the cut, etc. This work enables us to fix a daily task with a definite time allowance for each workman who is running a machine tool, and to pay the men a bonus for rapid work.

"The gain from these slide rules is far greater than that of all the other improvements combined, because it accomplishes the original object for which in 1880 the experiments were started—*i. e.*, that of taking the control of the machine shop out of the hands of the many workmen and placing it completely in the hands of the management, thus superseding 'rule of thumb' by scientific control.

"Unfortunately those fundamental ideas upon which the new task management rests mainly for success are directly antagonistic to the fundamental ideas of the old type of management. To give two out of many examples: Under our system the workman is told minutely just what he is to do and how he is to do it; and any improvement which he makes upon the orders given him is fatal to success. While, with the old style, the workman is expected constantly to improve upon his orders and former methods, under our system any improvement, large or small, once decided upon goes into immediate use and is never allowed to lapse or become obsolete, while under the old system the innovation unless it meets with the approval

of the mechanic (which it never does at the start) is generally for a long time, at least, a positive impediment to success. Thus many of those elements which are mainly responsible for the success of our system are failures and a positive clog when grafted on the old system.

"A long time will be required in any shop to bring about this radically new order of things; but in the end the gain is so great that I say without hesitation that there is hardly a machine shop in the country whose output cannot be doubled through the use of these methods. And this applies not only to large shops, but also to comparatively small establishments. In a company whose employees all told, including officers and salesmen, number about 150 men, we have succeeded in more than doubling the output of the shop, and in converting an annual loss of 20 per cent upon the old volume of business into an annual profit of more than 20 per cent upon the new volume of business, and at the same time rendering a lot of disorganized and dissatisfied workmen contented and hard working, by insuring them an average increase of about 35 per cent in their wages. And I take this opportunity of again saying that those companies are indeed fortunate who can secure the services of men to direct the introduction of this type of management who have had sufficient training and experience to insure success."

It is with justifiable pride and well-merited satisfaction in great work well done that Mr. Taylor can conclude his address in the following words: "And let me point out that the most important lessons taught by these experiments, particularly to the younger men, are: Several men when heartily co-operating, even if of everyday caliber, can accomplish what would be next to impossible for any one man, even of exceptional ability. Expensive experiments can be successfully carried on by men without money, and the most difficult mathematical problems can be solved by very ordinary mathematicians, providing only that they are willing to pay the price in time, patience and hard work. The old adage is again made good, that all things come to him who waits, if only he works hard enough in the meantime."

TIDAL POWER FOR COMPRESSING AIR.

AN ACCOUNT OF A LARGE TIDAL POWER PLANT WHICH IS ABOUT TO BE CONSTRUCTED ON THE COAST OF MAINE.

Wm. O. Webber—Engineering News.

THE enormous quantities of energy locked up in the tidal movements of the ocean and its tributaries have tempted men to devise means for their utilization ever since the dawn of engineering, but the direction of this power of nature to the use and convenience of man has hitherto made but little progress.

A new attempt, which has large promise of success, is about to be made on the coast of Maine, where an air-compressing plant will be installed, and it will be of interest to review the main features of this scheme, as given by its designer, Mr. Wm. O. Webber, in the *Engineering News*.

This plant is situated at South Thomaston, near Rockland, Maine, and will be based on the Frizell method, with the addition of modern improvements devised by Mr. Webber, and will thus differ from some other plants, such as those at Norwich, Conn., and Magog, Quebec, which have used the Taylor system of compressing air by water power. These plants, moreover, while utilizing the energy of falling water, are not operated by tidal power.

"Careful experiments upon a large working model, erected at South Thomaston, last summer, have fully demonstrated the peculiar application necessary for the utilization of the flow between large tidal basins and the ocean. They also demonstrated that an economical compression of air can be accomplished with much less differences in water level than was claimed by Frizell.

"At South Thomaston there is a tidal basin with an area of slightly over a square mile, or 640 acres. The average rise and fall of the tide at this point is 12 feet.

This would, therefore, realize about 5,000 horse power on the basis of 70% efficiency of the compressing apparatus, which should be easily obtained, as the tests of the other plants mentioned have given much higher efficiencies.

"The 'head of fall,' or difference of level, in the case of tidal flow, simply governs the ratio of air that can be entrained with a given volume of water, and has nothing to do with the pressure. The depth at which the separation of the entrained air from the water takes place below the surface governs the pressure, and it has been demonstrated that, with a fall of 35 feet, the highest ratios of efficiency can be obtained, with the maximum ratios of air to water. At lower heads equally good efficiencies can be obtained, but at lower ratios of air to water. It is practical to arrange for storage chambers, connected with the separating chamber, sufficiently large to store air to the average capacity of the compressor, in order to cover the period of time at flood and ebb tide when the compressor would either not work at all, or else work at such low efficiencies as to be commercially impracticable.

"At Rockland, Maine, there is sufficient market for the available power in the stone and lime quarries and factories of the country, within a 20-mile radius. Contrary to the usually preconceived notions, it is practicable to transmit compressed air through pipes, long distances, with comparatively slight losses. It has been demonstrated by the Popp system, in Paris, that the leakage is very slight, and the four years' experience, at Norwich, Conn., shows the leakage to be nil. Hydraulically compressed air being a perfectly dry gas, the frictional resistance, in good, smooth-coated pipe, is remarkably low, and velocities of 50 to 70 feet a second are admissible. The cost of pipe lines is not so greatly in excess of electrical transmission lines, when the cost of step-up and step-down transformers, etc., are taken into consideration.

"There are many tidal basins along the coasts of the temperate zones, between the 40th and 50th parallels of latitude, which are commercially capable of developing in this manner an unfailing source of power. Moreover this source of power has no dry season in the summer and the cutting off of forests does not affect it. This power can be made available many miles inland from the shore at comparatively low costs, and, with the single exception of lighting, can be turned into useful work in direct competition with electrical power.

"The scheme at Rockland having been financed, work will begin in the early spring on the construction of the dam and the laying of pipe lines to the quarries of the Rockland, Rockport Lime Co., to the power-house of the Rockland, Thomaston & Camden Street Railway, and to several cities in whose streets distribution mains will be laid the same as gas pipes. It is expected that the plant will be completed in the fall of 1907." Its development will be followed with great interest.

A SUPPLY OF SKILLED WORKMEN.

THE SYSTEM OF TRAINING APPRENTICES EMPLOYED BY THE GENERAL ELECTRIC COMPANY AT ITS LYNN WORKS.

M. W. Alexander—American Society of Mechanical Engineers.

THE need for better training of its workmen, if America is to retain its industrial supremacy, has been appreciated by far-seeing men for some time past, and is now becoming more generally recognized, so that it has even been made the subject for special recommendation in the President's message.

Trade schools and industrial institutions are scattered about the country, and some of the most progressive manufacturers have established special courses for apprentices at their works. This magazine was among the first to stir up interest in the matter, and several systems of apprenticeship and industrial training have been described in these pages. But there is great necessity for a more general application of methods to provide for a supply of skilled workmen, and it will therefore be of value to make some extracts from a paper on this subject, presented by Mr. Magnus

W. Alexander at the recent meeting of the American Society of Mechanical Engineers.

Mr. Alexander gives an account of the apprenticeship system employed at the Lynn Works of the General Electric Company. This system offers to boys with a grammar school education, who are at least sixteen years old, an opportunity to learn a trade. After a trial period of a month or two, the boys are allowed to sign a regular apprenticeship agreement. The latter provides for a service of four years at stipulated wages along a progressive scale, which is set with a view of making the boys self-supporting from the start, and which increases from $4.50 a week during the trial period and the first six months, to $9.25 a week during the fourth and last year. A cash bonus of $100 is paid at the termination of the course, and a "Certificate of Apprenticeship" is given to the boy at that time.

"It is the aim of the General Electric Company to train skilled artisans in the various trades of machinist and tool maker, carpenter and pattern maker, iron, steel and brass molder, instrument maker, and electrical worker, in such a thorough manner that the leading positions in the factory, such as assistant foremen, foremen, master mechanics, and superintendents may be filled from the ranks of graduated apprentices.

"It is obvious that such leaders must possess some information besides the practical knowledge of the trade—an industrial intelligence, which has been admirably defined by the Massachusetts Commission on Industrial and Technical Education as: 'Mental power to see beyond the task which occupies the hands for the moment to the operations which have preceded and to those which will follow it—power to take in the whole process, knowledge of material, ideas of cost, ideas of organization, business sense, and a conscience which recognizes obligation.'

"In order to gain this result, the General Electric Company has correlated with its purely trade instruction at the machine a theoretical training of an eminently practical character, designed to supplement and amplify the former, so that the boy may be able to apply in the workshop the knowledge which he gains in the schoolroom.

"Every apprentice receives instruction in the class room for six hours a week during ten months of the year, no school instruction being given during July and August. This enables the boys to take a week's vacation in the summer without conflicting with their school work. The school rooms are close to the workshop, and the sessions are held during working hours, arranged in such a way that about one-fifth of the apprentices are at school at one time. The boys are paid the same wages during school hours that they would receive while working at the bench or at the machine. The object of this is to make them feel the importance of an education; some of the boys might otherwise be unwilling to obtain an education at the sacrifice of wages.

"The teachers in the schoolroom are men selected from the staff of engineers, draftsmen, and foremen of the General Electric Company, who are assigned for six hours a week to the work of teaching.

The subjects which comprise the course of studies are: mathematics, physics, technology, and mechanical drawing. The teaching is preëminently concrete and appliable to factory conditions.

"Examinations on the school work are held frequently during the year, and a final examination at the end of the course determines, to a certain extent, the standing of the apprentice, and the wages which the company considers commensurate with his value as a journeyman."

The main feature of the Lynn system, however, is the special shop directly under the control of the man in charge of apprentices. Beginning in a small way, this "apprentice training room" has grown in size and equipment until today it covers an area of about 10,000 square feet and is equipped with 105 representative machine tools, of all kinds, besides the necessary small tools and vises. "A stockroom of suitable size occupies one corner of the training room and is conducted in the same manner as a stockroom in any well managed manufacturing establishment. This equipment is large enough to instruct about 125 boys at one time.

"The man who has charge of this training room is an ingenious mechanician, who has himself served an apprenticeship,

has had charge of men and work, possesses the ability and patience to instruct beginners, and is peculiarly adapted to this kind of work.

"The instructor initiates the apprentices into the trade and lays the foundation for their future skill and efficiency. It is his duty, wherever possible, to inaugurate with the apprentices labor saving methods of manufacture, and to make and use labor-saving devices which thereafter will be accepted by the other factory departments. He can without difficulty develop the highest practical cutting speeds and thus set a standard in this respect to the whole factory organization. The training room stands for the best and most efficient methods, and is not hampered in its development along these lines by a hostile attitude which may be encountered in factory departments on the part of regular workmen, which is usually due to ignorance or misunderstanding of the true conditions. The shop instructor has two assistants, this small number being made possible by carrying out the policy of utilizing most of the apprentices themselves for assistant instructors. After an apprentice has learned thoroughly a certain operation, turning of pulleys, for instance, he is usually required to break in a new apprentice on this kind of work before he himself is taught another operation, boring, for example, by an older apprentice who has already learned this operation.

"In this manner, the apprentice is pupil today and teacher tomorrow, then pupil again and teacher once more. The advantage of this policy is obvious. It develops early in the apprentice the faculty to instruct, and keeps him wide-awake in his work. The young master will put forth his best efforts to impress the young recruit with his own achievements and the latter will often not hesitate to ask his boy teacher questions that he may not, out of false pride, ask the regular instructor. Couples of boys may, therefore, be seen in the training room almost every day. A study of their instructive and receptive efforts is quite interesting. Some of the apprentices are required to spend a few weeks in the stockroom and learn stockroom methods, or act as clerks to the shop instructor in order to become acquainted with the clerical duties of a shop foreman, the making out of time cards and reports, the ordering of raw materials, and the shipping of finished goods. The object of all this training is to make real workmen, and this can be achieved only by carrying on real work. All production in the training room, therefore, is of a commercial value."

A training room similar to the one just described for machinist apprentices, although less complete, owing to the smaller number of boys, is maintained for the patternmaker apprentices, and if there were enough foundry apprentices to make it worth while, a foundry training room would also be installed. An ideal trade school in the factory would be a separate building, with foundry, patternmaker and machinist training rooms, and class rooms on the top floor.

After the apprentices have spent from one-and-a-half to two-and-a-half years in the training room, according to their individual ability, they are transferred to factory departments where they serve a post-graduate course for the remainder of their apprenticeship. They are now under the charge and discipline of the respective shop foremen, but the training-shop instructor still retains his interest in them, and may transfer them from one department to another, either at the request of the foreman or of the apprentice, and may even take them back temporarily to the training room. If a disagreement between a foreman and an apprentice arises, the shop instructor acts as a mediator. He considers the apprentices as his boys and looks upon them in that light even after they have become journeymen. He passes final judgment on the apprentice when he determines the standing to be recorded in his "Certificate of Apprenticeship."

"The General Electric Company encourages all graduated apprentices to remain in its service and, as previously stated, hopes that in due time most of the assistant foremen and foremen in the factory will be graduated apprentices. Some of those who have shown a special ability in their drawing work in the class room are appointed as tool designers in the drawing office, where their combined knowledge of tool making and practical

tool designing puts them far ahead, in this line of work, of even college educated but not shop trained draftsmen.

Mr. Alexander suggests the employment of these training rooms, in the evenings and on Saturday afternoons, for the instruction of ambitious men who are doing common labor but who wish to become skilled workmen; and the system he describes could also be applied to a "school shop" in an industrial community, maintained with the support and for the benefit of the factories in the vicinity, no one of which may be in a position to have a separate training school of its own, but which could thus secure for themselves a steady supply of just the kind of workmen they desire.

CANADIAN RAILWAY CONSTRUCTION.

A REVIEW OF SOME OF THE RECENT DEVELOPMENTS IN THE BUILDING AND OPERATION OF RAILWAYS IN CANADA.

Engineering.

FEW persons outside of Canada have any adequate idea of the tremendous growth of her railway system which has been in progress for several years past. Rich agricultural lands and mineral regions have been opened up, and have required additional means of transportation to handle their products, and the building of railways across the continent, about the Great Lakes and over the mountains and plains has, on the other hand, led to the discovery of new sources of natural wealth, which in their turn have demanded transportation, and have induced the construction of more railway lines and branches.

A summary of some of the recent developments in Canadian railways has been given in a late number of *Engineering*, from which the following account is taken.

"Another important trunk system has been developed in Canada under the title of the Canadian Northern Railway Company. This company may be said to date from 1899, as it was in that year that the Winnipeg Great Northern and the Lake Manitoba and Canal Companies were amalgamated under the general style and title of the Canadian Northern Railway. The Lake Manitoba Railway and Canal Company commenced the construction of a line from Gladstone in 1895; 100 miles were completed by the autumn of 1896, and were at once brought into operation. In 1897 the line was extended 25 miles to Lake Winnipegosis. In 1898, under the charter of the Manitoba and South-Eastern Railway Company, a commencement was made with a grain-carrying trunk line from Winnipeg toward Lake Superior, of which 45 miles of track were laid. At the Lake Superior end, the Port Arthur, Duluth, and Western Railway was purchased and the rights of the Lake Ontario and Rainy River line were acquired. In 1899 the Northern line was extended to a point 195 miles from Gladstone, and before the close of the year the gap between the rails on the Lake Superior line was considerably lessened. In 1900 the Manitoba and South-Eastern line reached the Rainy River, where the construction of a large steel bridge had to be undertaken. The following year—1891—was remarkable in the annals of the Canadian Northern Railway, as it was in that year that the company took over from the Provincial Government the lines of the Northern Pacific and Manitoba Railway. This step secured a main line through the fertile Portage Plains, to a point within 19 miles of Gladstone. Branch lines to Brandon and Hartney, through fine grain areas, and a connection to the south from Winnipeg to St. Paul and Minneapolis were obtained by the acquisition, making an addition to the company's working mileage of 350 miles.

"In 1901 a line between Winnipeg and Port Arthur was completed. A section from Fort Francis to Port Arthur was taken over early in 1902; and with a total mileage constructed by the end of 1901 of upwards of 1200 miles of line, the Canadian Northern Railway took the third place among Canadian railways. Branches comprising altogether 166 miles were added in 1902; in 1903, 93 miles more were completed; and in 1904, 232 miles. The year 1905 witnessed the completion of the main

line to Edmonton from Kamsack—a distance of 546 miles. During 1906 the Northern line was carried to Prince Albert, and the Vassar cut-off (important as effecting a great saving in grain traffic from Southern Manitoba to the Lake front) was also completed. The acquisition of the Qu' Appelle, Long Lake, and Saskatchewan line, previously worked by the Canadian Pacific Railway Company, from Regina to Prince Albert, affords a connection with the Canadian Northern Railway at Prince Albert, and adds 250 miles to the company's system. Altogether the Canadian Northern Railway now comprises about 2800 miles of line. The main line of the Canadian Northern Railway has nearly 1000 miles in the centre of what is known as the wheat belt of Western Canada, and the company claims to have no mileage through unproductive territory. By its main line, branches, and projections it expects to reach the richest sections in Manitoba, Saskatchewan, and Alberta, and the most important distributing centres of the Canadian West. Its main line also opens out a great stretch of mineral wealth, and 80 miles of rich agricultural lands in New Ontario. Although a system of 2800 miles has been developed by the Canadian Northern Railway, the company has great schemes for further extensions in hand, including a line to Hudson Bay.

"In Eastern Canada it is proposed to build from the present Eastern Lake terminus round the north shore of Lake Superior to Sudbury. This will be accomplished by the Canadian Northern Ontario Railway, previously known as the James Bay Railway. The Canadian Northern Ontario Railway has authority to build from a point on the Toronto and Sudbury line, near the French River, to Ottawa, and also from Toronto to Ottawa. The Canadian Northern Quebec Railway, which is controlled by the Canadian Northern Railway, will have a main line between Montreal and Quebec, besides a line to Hawkesbury, where a connection with the Canadian Northern Ontario Railway will be effected. Some great works occur on the Canadian Northern Railway. The Fort Saskatchewan Bridge, for instance, comprises four spans of 190 feet each, and two 65 feet girders; the total length of steel is 890 feet. The bridge is built on concrete piers, and will have a height of 82 feet from low water. The North Battleford Bridge, across the Saskatchewan, is also an important structure, having eleven spans of 170 feet each.

"Rapid, however, as has been the development of the Canadian Northern Railway, it is still outpaced by the Canadian Pacific Railway, which has now 11,000 miles in operation. It was towards the close of 1885 that Lord Strathcona drove the last spike in the Canadian Pacific, which commenced its career with 4315 miles of track. That in the 21 intervening years nearly 7000 miles of extensions have been brought into operation is simply marvellous. The Canadian Pacific Railway claims to have fine steamers upon the Great Lakes, still finer upon the Pacific from Vancouver to Japan and China, and finest of all upon the Atlantic to Liverpool and London. The grain-elevators opened by the Canadian Pacific Railway have now a combined storage capacity of 34,909,000 bushels, this total being arrived at as follows:—Ontario elevators, 12,217,000 bushels; Manitoba elevators, 14,078,500 bushels; and Saskatchewan and Alberta elevators, 8,614,000 bushels. The Canadian Pacific Railway has also developed seventeen great hotels; six of these are in Eastern Canada, the others in the prairie cities of the West, or among the grand scenery of British Columbia. The expenditure of the Canadian Pacific Railway at Winnipeg alone last year is returned at 4,251,744 dollars. Twenty years ago the Canadian Pacific Railway owned 373 locomotives, 304 first and second class passenger and baggage cars, 47 dining cars and café cars, 25 private, official, and pay cars, 8253 freight and cattle cars, 171 other cars, and three steamers upon the upper lakes. The locomotives have now increased to 1109, the passenger and the baggage cars to 997, the private, official, and pay cars to 160, and the freight and cattle cars to 34,152. The annual earnings 20 years ago were 10,000,000 dollars, and the annual working expenses 6,000,000 dollars. Now the annual earnings have reached 61,000,000 dollars, and the annual working expenses have grown to 38,000,000 dollars."

A WEIGHTS AND MEASURES COMMISSION.

AN ARGUMENT FOR A TECHNICAL COMMISSION TO INVESTIGATE THE BRITISH AND AMERICAN SYSTEMS.

Henry R. Towne—American Society of Mechanical Engineers.

IN spite of, or perhaps because of, the fact that a bill to make the metric system compulsory in the departments of the United States government has been under discussion by Congressional committees for several years, the conflict between the pro-metric advocates and those who adhere to the present system is no nearer a settlement than at the beginning. Long arguments have been made by the partisans of each system, and the committeemen, few of whom have been qualified by technical training and experience to pass upon the complex issues thus presented, must have found it very hard to form any intelligent judgment on the merits of the controversy.

Before the adoption of the metric system in France and in Germany, the question was very thoroughly investigated by technical commissions, whose sittings extended over a term of about eleven years in each case, and the best expert advice was made use of in reaching the final decision as to the system and its details. At the present time, in the United States and Great Britain, where far greater interests are involved in any change than was the case in France, in 1801, and in Germany, in 1871, it seems only reasonable that the matter should be even more thoroughly studied than in former instances, and it is with this object in view that Mr. Henry R. Towne, in a paper presented before the American Society of Mechanical Engineers, advocated the establishment of a technical commission by the United States government to carefully investigate the whole question of weights and measures and to recommend any changes found desirable. Members of this commission, in coöperation with a similar commission to be appointed by the British government, would also attempt to secure complete uniformity in those measures which are now different in the two countries.

Mr. Towne, while frankly expressing his preference for the present system, believes that it is open to improvement and indicates some of the features that might be altered to advantage. He fortifies his position with many arguments, most of which are familiar to students of the sub ject involved. He shows that the United States and Great Britain and the British Colonies (except India) have a combined population of 150 millions and that the value of their annual manufactures is $11,012,000,000. France and Germany, the two chief metric countries, have a population of 95 millions and their manufactures are valued at $5,197,000,000, while all the metric countries of any importance, with a combined population of 203 millions, reach a total of only $11,007,000,000 in the yearly value of their manufactures, or not quite as much as the United States and the British Empire.

When France and Germany adopted the metric system, they had been laboring with a variety of different systems, and any change which ensured uniformity in place of the old disorder would have been a good one. They were bound to have some change, and while they were about it, it was well that they chose such a scientific and logical system as the metric. Moreover, when they made the change, particularly in the case of France, their manufacturing industries were insignificant compared with what they are today, and so they started with a tolerably clean slate. Now, however, it would be much more difficult for either of them to make the change, and for the United States and Great Britain, with their enormous manufacturing interests, the difficulties are many times multiplied.

France and Germany changed to the metric system in order to secure uniformity. But the United States has practically absolute uniformity now, and, with the exception of the measures of capacity, the United States and the British Empire have international uniformity, their units of length, area and weight being identical. A technical commission, such as advocated by Mr. Towne, could devise some means

for harmonizing whatever differences still exist, and in this connection, a suggestion may be here offered: the United States gallon contains 231 cubic inches, the British 277.27, their average being about 254 cubic inches. Now 4 liters contain very nearly 244 cubic inches, only about 4 per cent away from the above average, and if a compromise between the United States and the British gallon could be agreed upon, why not make it exactly equal to 4 liters, and thus harmonize at least the capacity measures in our system and the metric? If this were done, it would, of course, follow that the quart would equal the liter, and in dry measure the United States and British bushels should then be made equal and an exact multiple of the quart, the latter being made the same in both dry and liquid measure.

Whatever difference of opinion may exist as to the respective merits of the inch-pound system and the metric, and as to the advisability of making any change, it must be admitted that the questions involved are very complex and far-reaching, and many of them essentially technical in character. In order, then, that these questions may be properly considered and a reasonable and satisfactory settlement of the matter arrived at, Mr. Towne proposes the appointment of a technical commission, as set forth in the following bill, which has been introduced in Congress and been referred to the Committee on Weights and Measures:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That a commission is hereby created, to be called the Commission on Weights and Measures, which shall be composed, in the discretion of the President, of not less than nine nor more than fifteen commissioners, to be appointed by the President, by and with the advice and consent of the Senate, and to be selected from various professions and pursuits and in such manner that, so far as practical, every important interest, particularly scientific, industrial, agricultural, commercial, mechanical, and maritime interests shall be represented thereon. Any commissioner may be removed by the President for inefficiency, neglect of duty, or malfeasance in office, and the President, by and with the advice and consent of the Senate, shall fill by appointment all vacancies which may occur in said commission.

Sec. 2. That it shall be the duty of the said commission to investigate and to report to the Congress upon the subject of measures of length, weight, and volume in use throughout the United States and in other countries, in order to enable the Congress to decide what action, if any, is feasible and expedient for the improvement of the system of weights and measures now in use in the United States, and to that end the investigations of the said commission shall include: First, the question of retaining or modifying any or all of the present standards of length, weight, and volume employed in the United States; second, in case present units are to be retained, the question of improving and simplifying, especially for the purposes of computation, the subdivisions and multiples of such units; and third, in case any or all of such present units are to be discarded, the desirability and expediency of substituting therefor the so-called metric units and the system based thereon.

Sec. 3. That each commissioner so appointed shall receive a salary during his term of office of three thousand dollars per annum; that the office of the commission shall be located in the city of Washington, District of Columbia; that the commission shall give reasonable time for public hearings, if any shall be deemed necessary; that, if expedient, it may appoint a subcommission or subcommissions of its own members to make investigation in any part of the United States; that it shall have the authority to send for persons and papers and to administer oaths and affirmations. It shall be authorized to employ such assistants and clerks as it may reasonably require for the proper conduct of its work, and may fix the salaries to be paid to all persons employed by it, and that all necessary expenses, including the salary of the commissioners, clerks, stenographers, messengers, rent for place of meeting, and printing and stationery, shall be paid from any money in the Treasury not otherwise appropriated; however, not to exceed one hundred thousand dollars per annum for expenditures under this section, to be paid upon vouchers to be approved by the

chairman of the commission. That the commission is empowered to make all necessary, convenient and proper rules and regulations of practice and procedure for the transaction of its business.

Sec. 4. That the said commissioners shall proceed with their work as rapidly as may be consistent with thoroughness and shall from time to time report the result of their labors and investigations to the Congress, and that when their work shall have been concluded the said commissioners shall embody the result thereof and their definite recommendations in a final report to the Congress; that their report shall be accompanied by notes which shall briefly and clearly state the reasons for the recommendations therein made and the legislation, if any, advocated by them.

Sec. 5. That immediately after the passage of this act the President of the United States shall invite the Government of the United Kingdom of Great Britain and Ireland to participate in a conference for the improvement and unification of the standards of length, weight, and volume used by the United States and by the United Kingdom, such conference to be held at such place or places in Europe or in the United States as may mutually be agreed upon by the Executives of the two Governments, and that the President shall, by and with the advice and consent of the Senate, appoint from the commission to be created under the provisions hereof, five commissioners to attend such joint conference on behalf of the United States. The commissioners so appointed members of such international conference shall receive a salary, additional to that provided under section three hereof, of two thousand dollars per annum and also their reasonable expenses as commissioners to such international conference, to be approved by the Secretary of State, said compensation and said expenses to be appropriated out of any money in the Treasury not otherwise appropriated.

METAL CORROSION IN CINDER CONCRETE.

A REPORT ON EXPERIENCE IN SAN FRANCISCO IN THE CORROSION OF REINFORCING METAL IN CINDER-CONCRETE FLOORS.

Structural Association of San Francisco.

THE San Francisco disaster has had at least one good result. It has been an unparalleled working test, under the most severe conditions, of modern methods of building construction, and it has afforded a great opportunity to investigate the behavior of all kinds of materials under the influence of shock and fire. This opportunity has been taken advantage of by engineers and builders from all parts of the country, and many valuable lessons have been learned. The results of some of these investigations have already appeared in the form of books and magazine articles, and among the latest reports is one on the corrosion of metal in cinder-concrete floors, presented to the Structural Association of San Francisco.

A few months ago, Mr. C. F. Wieland called the attention of the above association to some examples of the serious corrosion of the metal in reinforced-concrete floors, the concrete of which was made with cinders, and after being discussed the subject was referred to a committee, consisting of Messrs. Luther Wagoner and Theodore H. Skinner, who, after investigation, submitted the following report:

"We examined the floor slabs at Mr. Wieland's office, and later each of us carefully examined the floors in the following buildings. * * * The cinder concrete is somewhat porous with occasional voids and also contains coal from dust up to lumps ¼-inch diameter; rust spots occur in the concrete, and where such spots are in contact with the metal, the corrosion is severe. The rust spots are sometimes 1 inch across, quite soft and easily removed by the finger nail. Occasional splinters of wood occur in the concrete, which shows that the heat was not severe as the wood is not charred. From the position of the floors it is certain that no water has reached the concrete since April 18th and that the corrosion was prior to the fire, but it appears to be more

marked where floors have been exposed to the rains since the fire. The corrosion is irregular in amount. In some cases the expanded metal is only slightly rusted and in places it is entirely destroyed; several places were noticed where a small semi-circular patch had been removed from the edge of a metal strip; also at times it crosses the surface of the strip in a line which suggests it followed a surface crack in the metal. There seemed to be a tendency to corrosion at certain points in the diamond mesh, which would indicate that the metal had been strained in the process of slitting and expanding, but there is not positive proof of this.

"The extent of the corrosion is great enough to seriously endanger the safety of the floors, and it is not probable that the floors would have supported their loads longer than one to three years.

"Various reasons for the corrosion of metal in cinder concrete have been given; quite prominent among them is the belief that it is due to sulphur in the cinders. In order to corrode metal the sulphur must first oxidize to H_2SO_4, and if there is any notable amount of cement present, it would be absorbed by the cement. It is not probable that sulphur can rust metal unless it is either close to it or the concrete is very deficient in cement.

"Prof. Norton (see Report III, Insurance Experiment Station, Boston) made several hundred experiments and it is his opinion that the corrosion is not due to sulphur, but to a too dry mixture, which fails to properly coat the metal, and air and moisture enter the pores of the concrete and set up rusting action. This view is also confirmed by Booth, Garrett & Blair, who state that a cinder containing two-tenths per cent. of sulphur will not corrode steel, provided the concrete has sufficient cement mortar to close up the voids and cover the metal.

"It is stated by makers of sheet metal pipe that there is a marked difference in the life of pipe that comes here, rail or sail. The exposure to a sea voyage renders the usual protection by dipping useless, as the surface rusts under the dip and the coating falls off of the pipe. The pipe makers state that this happens to sheets apparently unaffected by rust when dipped. The slitting and expanding of the metal sheets may cause minute cracks upon the surface of the metal. If this be combined, as is the case here, with a thin slab of concrete, porous and ranging in thickness from 2¾ to 4½ inches, with the metal in many cases flush with the bottom of the slab, there is an ideal condition for the rusting of the metal. Hambuechen (Univ. of Wis.) made a study of corrosion and has proved that a point of segregated carbon is always an initial point of corrosion and has shown that burnishing steel or iron protects it notably by removing the focal points; he has proved that rusting sets up a feeble current, the segregated carbon points acting as poles. Possibly the presence of much free coal and coke in the cinder may be a contributing cause by setting up feeble electric currents or by conveying them from earth currents due to leaks from trolley wires. In one of the buildings, the upper floors are of sound rock concrete, and where the corrugated bars were exposed they appeared as sound as when placed.

"Prof. Norton advises coating the metal with a paint of neat cement or dipping the metal in a thin grout. This is hardly a practicable method here, and it is doubtful if it could be done with that thoroughness which such work demands.

"It is recommended that the Structural Association try to amend the present building law so as to exclude the use of cinder concrete in floor slabs or for fire-proofing. That provision be made in the building law for the examination and tests of any existing cinder concrete now in use or that may be used at some later period."

In commenting on this report, the *Engineering News* remarks: "The San Francisco committee proposes to avoid all risk by forbidding entirely the use of cinder concrete. But is there not something to be said on the other side of this question? Cinder concrete has a very real and practical advantage in its lighter weight, and another advantage on which stress is laid by many engineers in its greater resistance to fire. There may be places where the fire risk might justify the use of cinder concrete in preference to stone concrete even if gradual corrosion of the reinforcement were a fore-

gone certainty. In the present state of our knowledge, therefore, it seems premature to forbid by law the use of cinder concrete.

"It may be remarked in this connection that the material which goes into cinder concrete is almost as varied in character as the material from which the cinders are derived, and in nine cases out of ten this material is a good deal short of what any competent engineer would regard as ideal.

"There is a real demand for a material for concrete aggregate which shall be at once light in weight, reasonably strong, stable in structure, chemically inert, and last but by no means least, low in cost. Hard clinkers from boiler furnaces are probably as near an approach to this as is now commercially available; but something better may yet be brought forward. Blast-furnace slag might perhaps be made use of for the purpose if produced without free sulphur and of stable structure. An ideal material would be volcanic pumice stone, vast quantities of which are said to exist in Mexico and other volcanic countries; but the cheap transportation problem would have to be solved to make this commercially available."

DEVELOPMENTS IN RADIO-TELEGRAPHY.

AN ACCOUNT OF SOME RECENT WIRELESS TELEGRAPH EXPERIMENTS IN DENMARK WITH AN ARC TRANSMITTER.

Valdemar Poulsen—Elektrotechnische Zeitschrift.

MOST of the wireless telegraph systems in extensive operation have used a spark gap as the origin of the radiations which are sent out by the transmitting station. Such radiations consist of a train of waves which are rapidly damped out. The spark oscillates at high frequency between the terminals of the gap a few score or a few hundreds of times, its energy being all dissipated in a small fraction of a second. Even if the initial amplitude is very great, the total energy radiated will not amount to much on account of this rapid decay of the oscillations. Many attempts have been made to generate high-frequency waves continuously, which, among other advantages, permits much closer syntonizing of the apparatus and makes the transmission of radiant energy more efficient. Mr. Valdemar Poulsen, of Copenhagen, the inventor of the telegraphone, has recently been doing some very successful work along these lines, and in a late issue of the *Elektrotechnische Zeitschrift* there is a report of a lecture which he delivered before the Elektrotechnische Verein, on the occasion of the International Wireless Telegraph Conference at Berlin, describing his experiments and some of their practical applications.

By connecting an oscillating-current circuit with suitable inductance and capacity in parallel with a direct-current arc, part of the energy of the direct current is converted into alternating current, and the arc will become the origin of undamped electric waves. Under ordinary circumstances, the frequency of the oscillations is of the order of the audible tones, running up to 30,000 or 40,000 a second, but by placing the arc in an atmosphere of hydrogen or hydrocarbon, Mr. Poulsen found that the frequency could be raised to a million, or more.

At first Mr. Poulsen thought that this favorable influence of the hydrogen was due to its great cooling power, for it is certain that hydrogen does have this cooling effect. It is also a fact that pure nitrogen and some other gases enable the arc to oscillate more rapidly than when in air. Oxygen appears from this to have an injurious influence, either because its heat of combustion raises the temperature of the arc and the electrodes, or because there is a mechanical retarding effect due to the chemical reaction. But the peculiar advantage of hydrogen as a medium for the oscillating arc lies in its specific physical properties. With the high velocity of the hydrogen atom are connected its great capacity for heat and its high speed of ionization, so that its action on the arc is not only thermal, but more especially electrical.

If the arc is placed in a strong magnetic field, the voltage drop will generally be very large in proportion to the length of the arc; for instance, 440 volts for a length of 3 millimeters. Under these conditions, the inductance in the oscillating circuit can be considerably increased at the expense of the capacity, from which it again follows that the potential difference at the terminals of the condenser can be made very great. Experience has shown that the use of the magnetic field enables the oscillating circuit to act more effectively.

In order to determine if the cooling influence of the hydrogen was one of the factors in increasing the effective working of the arc, experiments were made, and it was found that with a copper anode and carbon cathode there were favorable results. Artificial methods of cooling, as by water circulating through a hollow anode, were found to be advantageous. In general, hydrogen with the addition of some hydrocarbons gave better results than hydrogen alone, so that ordinary illuminating gas, or hydrogen carburetted by flowing through naphtha, was used. The arc is enclosed in a chamber, through which a flow of gas is maintained, as the oscillations appear to render the gas inactive so that it has to be continually renewed.

In the practical application of this system, the transmitting station is arranged so that the oscillating and radiating circuits are either decidedly close coupled or decidedly loose coupled. With the ordinary spark systems, if they are to be syntonized, it is necessary to employ a loose coupling, but this has to be modified somewhat for the sake of efficiency in operation. With the arc transmitter, however, the tuning can be as exact with close coupling as with loose, and it should be either one or the other, as a compromise between the two does not give definite syntonization.

The signals can be made in a variety of ways: a good method is to have the sending key throw the aerial and ground wires in and out of connection with the rest of the system, in which the oscillations continue uninterruptedly. It is well, in this case, whenever the key cuts out the aerial to have it throw in a compensating oscillating circuit which has but feeble radiating powers. Another procedure is to have the key short-circuit a resistance in the oscillating circuit or aerial circuit. This method requires very simple connections and permits of rapid telegraphing, while the sparking at the key contacts is microscopically small.

It is altogether characteristic of this system that the sparking at the key is far less than with the spark-gap systems, as the energy used per unit time is much smaller.

In the receiving system it is of the highest importance to utilize resonance as much as possible, and the aerial and oscillating circuits should therefore be coupled very loosely. In order to prevent the wave detector itself from exerting any damping influence, it may be so arranged as to be connected only intermittently with the oscillating circuit. This is accomplished most conveniently by means of a small interrupter, called a "tikker," which makes a large number of contacts per unit time, each contact, however, occupying only a very brief interval. Various forms of wave detector can be used, such as the electrolytic or the thermal, combined with a telephone.

Stations have been built in Denmark in which this system has been successfully used, the silent, oscillating arc taking the place of the noisy spark of the ordinary systems. Syntonization as close as one per cent has been attained; that is to say, a pair of stations can operate with wave lengths of 600 meters, and another pair in the same territory with waves of 606 meters, without interfering with each other. Waves having lengths of from 300 to 3000 meters can be conveniently generated, so that several hundred stations may operate within the same sphere of influence, it is said. As more energy is generated with the longer wave lengths, these are used for the long-distance work, and they naturally go with the taller masts, while the short waves and lower masts are employed for the near-by signaling.

The advantages of such a system may be summed up as follows: It permits of very close syntonization, and prevents interference of different stations in the same

region; there is very little trouble from atmospheric disturbances and accidental electrical discharges; and there is a comparatively low potential in the aerial.

The undamped, continuous oscillations are well suited for the realization of wireless telephony, and in another issue of the *Elektrotechnische Zeitschrift*, Herr Ernst Ruhmer, who has already achieved considerable success in telephoning with the help of a beam of light, describes some laboratory experiments with an arc wave generator, by which speech was transmitted through space very well for short distances. Work that has already been done in the United States along somewhat similar lines, together with such experiments, gives hope that before long wireless telephony over considerable distances may become a practical reality.

CLAY ROAD BUILDING.

THE CONSTRUCTION OF SAND-CLAY AND BURNT-CLAY ROADS IN THE ATLANTIC AND GULF STATES.

W. L. Spoon—U. S. Office of Public Roads.

ALTHOUGH much has been accomplished by the "good roads" movement in the United States, the improvements have been principally near the large centers of population, where the bicyclists and automobilists have been most active and persistent, and there are great areas, particularly in the thinly settled districts, where the roads are practically impassable at certain seasons and are never in really good condition.

The national government is endeavoring to remedy this state of affairs, and the Office of Public Roads has already done much good work by practical instruction, by building experimental roads, and by publishing the results of its own experiments and other valuable information on roads and road construction. A recent bulletin, No. 27, of this Office, prepared by Mr. William L. Spoon, gives an interesting report on the construction of sand-clay and burnt-clay roads, from which some abstracts are here taken.

Sand-Clay Roads.—The two properties of clay most important in road building are: first, plasticity, and second, the property of slaking when first wet after having been uncovered. The most plastic clays are technically known as "ball" clays. A lump of clay of this sort preserves its form some time after being immersed in water. Other clays, because of their porous structure, slake when placed in water, like quicklime.

A suitable proportion of sand and clay and a thorough mixture of the two are regarded by Mr. Spoon as indispensable if a satisfactory result is to be secured. The best sand-clay road is one in which the grains of sand are in contact and the voids are entirely filled with a good binding clay. Such a road will stand comparatively heavy traffic for a long time, even when the subsoil is sand or clay. If an excess of clay is used the grains of sand are not in contact and are free to move about, so that no particle exerts more resistance to pressure than if the entire mass consisted of clay alone. If too much sand is used the mixture lacks binding power and will soon disintegrate.

In constructing sand-clay roads two distinct conditions are met. The road may have a sandy subsoil, the objectionable features of which are to be overcome by the addition of clay, or the subsoil may be clay to which sand is to be applied. The methods of construction advised by Mr. Spoon for the two cases are radically different.

The most important consideration is that of drainage. If natural drainage does not exist artificial drainage must be provided. On a gravelly or sandy soil the natural drainage is usually excellent and it is often unnecessary to do more than give the road surface a crown to divert the water from it. Where such favorable conditions are not found the roadbed must be raised and side ditches dug so that the road will shed water thoroughly.

The cost of sand-clay construction varies with the local conditions. On the assumption that the clay can be procured within a mile of the road to be improved, and that the cost of labor is about $1 per day and

teams $3 per day, the cost of one mile of 12-feet sand-clay road on a sand foundation covered with clay to an average depth of 6 inches would be approximately as follows: Crowning and shaping road with machine, using two teams at $3 and one operator at $1.50, $7.50; loosening 1,173⅓ cubic yards of clay with pick and shoveling into wagons, at 15 cents per cubic yard, $176; hauling same quantity of clay, at 23 cents per yard, $269.86; spreading clay with road machine, using two teams at $3 and operator at $1.50 for three days, $22.50; shoveling sand on clay at ½ cent per square yard, $32.50; plowing, using one team for four days, $12; harrowing, one team for two days, $6; shaping and dressing with road machine, two teams and expert operator for two days, $15; rolling, estimated at ½ cent per square yard, $32.50; total, $579.26.

The estimated cost per square yard of road surface computed on the above basis would be about eight cents, or $579.26 per mile. The cost of building a sand-clay road on a clay foundation would be about the same, but might be less since sand can be handled more cheaply than clay. According to the experience of the Office of Public Roads, the cost of such roads in the South has, in most cases, run from $300 to $800 per mile.

Burnt-Clay Roads.—In large areas in the South, particularly in the Mississippi Valley, the existing clays are very plastic and sticky and little or no sand is found. These sticky clays are locally known as "gumbo" and "buckshot." Special experiments have been carried on by the Office to see what could be done in the way of burning or clinkering them so as to become capable of sustaining traffic. The laboratory experiments having shown that they could be clinkered at a low temperature, an experimental road was built at Clarksdale, Miss. This road is proving satisfactory and several other sections of similar road have been constructed in the same locality, concerning which only favorable reports have been received.

Gumbo clay is black, owing to the large amount of vegetable and organic matter it contains. It is very sticky when wet and is almost wholly free from grit and sand. By burning, its plasticity is destroyed and a light clinker is produced, which, while not very hard, forms a smooth surface and seems to wear well. It is only necessary to clinker a sufficient percentage of the clay to neutralize the sticky character of the natural material.

The fuel used should be sound and fairly well seasoned wood cut in uniform lengths of 4, 8 or 12 feet and stacked along the road at convenient intervals. About one cord of wood to 8 linear feet of road 12 feet wide is required. With the cord wood may be used chips, old fence rails, coal slack or other convenient fuel.

After grading the road to an even width between ditches it is plowed as deeply as practicable. Furrows are then dug across the road about 4 feet apart and extending on either side 2 feet beyond the width to be burned. Across the ridges formed between these furrows the first course of wood is laid longitudinally so as to form a series of flues in which the firing is started. The soundest cord wood is used for the first course, laid so that the sticks touch, forming a loose floor. Across this floor is thrown irregularly another layer of wood with spaces between in which coarse lumps of clay are piled. Another layer is now closely laid, parallel to the first, forming a second floor. All the openings in this layer should be filled with chips, bark and other combustible material. Over this is piled a 6 to 8 inch layer of clay, in lumps of all sizes, together with fine material. Finally the whole is tamped and rounded off so that the heat will be retained as long as possible. When coal slack is available the two top layers of wood may be omitted and the coal slack thoroughly mixed with the clay.

It is necessary to get the fires well under way before the first layer of wood is burned through. Usually 15 to 20 flues or lengths of cord wood are fired at once, the material being divided into convenient firing sections by omitting at intervals the charge of wood across one transverse furrow. The best results are obtained by firing all the flues of a section at once and maintaining the combustion as evenly as possible. This last may be accomplished by adding light dry kindling where the fire dies down and banking the mouths of the flues where the combustion is too rapid.

In order to obtain the maximum draft, firing should always be begun on the windward side.

If the firing is done properly the clay top of the kilns and the ridges between the flues will be burned thoroughly and the character of the material will be so changed that when wet it will not become muddy. When the mass has cooled it should be given a high crown with a road machine in order to allow for the compacting of the material under a roller. The road must now be rolled until its surface is hard and smooth. The finished crown should be at least one-half inch per foot.

The main advantages of thus burning a road are: first, that the cost of hauling the clay is avoided; second, that the subgrade is burned as well as the surface material. The items of cost of the experimental road, 300 feet long, at Clarkesdale, Miss., are as follows: 30½ cords of wood at $1.30 per cord, $39.65; 20 loads of bark, chips, etc., $6; labor at $1.25, and teams at $3 per day, $38.30; total cost of 300 feet, $83.95; total cost per mile, $1,478.40.

THE PHILOSOPHY OF ENGINEERING.

A PRESIDENTIAL ADDRESS TOUCHING ON THE RELATIONS OF ENGINEERING TO OTHER FIELDS OF HUMAN ACTIVITY.

Sir Alexander B. W. Kennedy—Institution of Civil Engineers.

SIR Alexander Kennedy, better known, perhaps, as Professor Kennedy, on account of his former occupancy of the chair of engineering at University College, London, has been connected with so many different branches of engineering, both practically and academically, that he is peculiarly fitted to take a broad view of his subject, and in his recent presidential address before the Institution of Civil Engineers, he treats of the relations of the engineer to the world about him and to his fellow men, in a manner which is often original, and never dull. In spite of Sir Alexander's assertion that some superior literary persons deny that technical literature has any claims to literature, as such, it must be conceded that some of the addresses before British engineering societies, of which the one under discussion is an excellent example, possess real literary charm and present interesting ideas in an entertaining and elegant style, which is more than can be said for much "literary" matter. Only a few parts of the address can be given here, but they may serve as examples of the whole.

Sir Alexander does not claim everything for the engineer, and says that if he had never existed the world would only have developed along other lines, which would, perhaps, have conduced as greatly to the happiness of mankind, as has the actual course of evolution. "We have no right to assume that if there had been no railways and no telephones, no electric light and no motor omnibuses, the world would have been a whit less civilized, less moral, or less happy than it is.

"This is by way of making it clear that I am not going to start on any discussion of the engineer with the assumption that he is the salt of the earth. But I do start from the position that, as his predecessors were responsible for starting the world on 100-pound rails when it refused any longer to jog contentedly along on macadam, he himself must now do all he can to see that the lines laid and being laid are leading in the right directions, and not assume complacently that all roads lead to perfection simply because he has put them down. The world has chosen, for the present, that it will travel by steam or petrol. I daresay the choice is an unwise one. I confess I should like to spend the evening in setting before you a glimpse of a glorious world in which there would be as few engineers as there now are philosophers. That, however, would be obviously unsuitable for this particular occasion. The world intends to go by machinery for our time, at any rate, and we engineers are the drivers and the signalmen at the same time. I hope we may be able to do our work with a full sense of the serious responsibility of this double position.

"We engineers, then, because of the nature of our work and its relation to the lines taken by modern development, stand

in particularly close relationship to all the activities round us, to commerce and to social life. The subjects with which we have to do, and the ways in which they have to be dealt with, bring us into intimate contact with many branches of physical science, while our modes of thought and action inevitably affect art, interfere with Nature, and even react on philosophy. Can we cultivate such an ideal that our widely-extended influence shall really be for the benefit of the community, not only in giving them good railway service and cheap power, but in some wider and much more important fashion?

"In relation to science, I have always claimed for engineers a very high place, a place much higher than some of my purely scientific friends are disposed to allow them. M. Jourdain talked prose all his life without knowing it. So I really believe not a few engineers have spent their whole lives in scientific work while they were nominally only earning their daily bread in ordinary mechanical pursuits. It is not, however, so much that engineering is a science as that the scientific spirit is often the basis of engineering, and that when this is the case, engineering becomes as truly scientific as any other branch of exact research, and none the less scientific because it is also the means of making an honest living. Engineering problems differ from ordinary academically 'scientific' problems, partly in that they are much more complex, and consequently more difficult of anything like exact solution, and still more because—exact or inexact—some solution to them has always got to be found. Not only must the solution be found, but it has to be translated into steel and gun-metal, as well as into pounds, shillings and pence, and any mistake will entail very much more serious consequences than a controversial paper in the *Philosophical Magazine* or a letter in *Nature* pointing out a wrong estimate of terrestrial radioactivity in pre-historic epochs."

The question of the conflict between engineering and art is gone into. It is admitted that whereas their paths ought to be parallel, they too often intersect, and the intersection is not infrequently at right angles. The causes for this unfortunate state of affairs are superficial rather than fundamental. There is no real reason why a machine or structure should not be built to perform its functions in the most efficient manner mechanically and at the same time please the artistic sense. In fact, the tendency nowadays is decidedly in the right direction. Ugliness is not inherent in mechanical structures. The ugly period in engineering was only a transitional one, and marked a rudimentary stage, which is now giving way to something better and more beautiful. The city, instead of being a blot on the landscape and full of commonplace ugliness, can be made to comprise the highest architectural beauty together with all the modern conveniences, if the engineer possesses reasonable taste and intelligence, and is permitted to make the best use of his knowledge and opportunities.

Speaking of a kindred subject, the relation of engineering to nature, Sir Alexander says that "our interference with nature—that is, especially with natural scenery—comes practically under two heads—the erection of works for the utilisation of water, either for use in cities or for power, and the construction of railways in mountainous or other beautiful districts.

"The first is the easier to deal with. The conversion of upland valley bottoms into lakes by the construction of dams seems to me to be out of court at once. I am not inclined to admit that to cover boggy peat land with blue water is doing any harm to Nature, or that a fine masonry dam is an eyesore.

"There remain to be considered mountain railways, or railways in mountain districts. There come first the great lines, like the Simplon, which run through mountainous districts, and which are important means of continental communication. I have already suggested that it might possibly have been better for the world if it had stuck to stage-coaches, and had never gone travelling; but the world itself elected otherwise, and such works, therefore, require no justification. Also I must add that some of these—the St. Gothard and the Albula lines are examples—rather add interest to the landscape than disfigure it."

He is very severe, however, on some

other classes of mountain railways, especially those that lead to the summits, but we are afraid that he speaks here rather as a member of the Alpine Club than as president of the Institution of Civil Engineers. When engineering structures disfigure nature, she is fortunately able to cover up the scars in a short time, if the wound is not too great; and in this respect, also, engineers are learning to accommodate themselves to nature, and to make their structures harmonize as much as possible with their natural environment.

The relations of engineering to law are then considered, and various matters concerning contracts and specifications, contractors and consulting engineers, are discussed.

In taking up the "labor" question, Sir Alexander remarks that: "it goes without saying that the relationship of engineering work to the industrial life of the country is of vast importance. Directly, engineers are very large employers of labor; indirectly, through our railways and manufactures, we must be responsible for the employment of more 'labor'—using the word in the popular sense—than any other set of men. It would obviously be impossible for me, in the few minutes at my disposal, to discuss here our industrial relationships. Only let me express an earnest wish that, for the sake of the well-being of the country as a whole, and of everybody connected with engineering, from the fitter's mate to the past-president, and for the sake of the work which we are carrying on and carrying out, these industrial relations be kept out of the unstable whirlpool of politics.

"Speaking to a society which contains so many employers, I ought, perhaps, to add a word here. It is only fair to recollect that it is only within the last century or so that society in general has really recognised that no one of its sections has paramount importance, but that the welfare of all sections is equally desirable. Probably there was no such actual preaching of class enmity a century ago on the one side as there is at present on the other. But that was not because the wealthier side was broader-minded then than the poorer side is now, but only because it was not thought worth while to treat as serious enemies those who were too often assumed to be created by Providence to be 'inferiors.' That feeling has happily gone, and not unnaturally the spread of broader and more humane ideas has started with those classes to whom—living a less anxious and a freer life—it is more easy to be genuinely liberal. In time, let us hope, the feeling will extend itself to all classes of citizens."

With regard to the future, the speaker found it difficult to prophesy with any certainty. The laws of evolution hold only to a limited extent in engineering progress, and a new "species" of machine or process is likely at any time to spring into being, owing to the disturbing influence of the inventor, in this way corresponding to a "special creation" in biology. After such a species is created, however, it does follow a general law of development until it is supplanted by a fitter one. "It would, however, seem natural to hope, in looking forward, that one of the chief directions in which the engineers of the future will carry out successful work will be that of increasing directness, avoiding transformation, where possible, and greatly increasing the efficiency of those that remain."

ELECTRIFICATION OF SWISS RAILWAYS.

A REPORT ON THE POWER REQUIRED TO OPERATE ALL THE RAILWAYS OF SWITZERLAND BY ELECTRICITY.

Prof. W. Wyssling—Schweizerische Bauzeitung.

WHILE the electrification of railways for local and surburban traffic is being carried out on a large scale in different countries, there is still doubt as to the economy of operating whole systems by electricity, particularly where the distances are great and the traffic not dense. The conditions for the use of electric traction on trunk lines appear to be most favorable in a comparatively compact country, where coal is scarce and water power abundant. Such conditions

exist in Switzerland in a preëminent degree, and the question in that country is not so much of the purely technical advantages of electric traction, which have been of determining importance in many other places, as it is an economic one, concerning, as it does, the utilization of its own water power instead of burning the coal imported from foreign countries.

On account of its great importance to Switzerland, a government commission was appointed a couple of years ago to thoroughly investigate the question of the electrification of all the railways of the country. Work has been in progress now for some time, and a very careful estimate of the power required to operate the railways has been made, and has lately been published in the *Schweizerische Bauzeitung* by Prof. Dr. W. Wyssling, the general secretary of the commission.

The amount of power necessary depends, in a measure, upon the electro-mechanical system employed, and, to a still greater degree, upon the methods of conducting transportation. The influence of the former was eliminated for the time being by confining the calculations to the energy required at the driving wheels of the train. The railway administrative system had to be taken into account, however, and it was assumed that the methods hitherto employed under steam operation, where a relatively small number of heavy trains are run, instead of light trains or single cars at frequent intervals, would be continued for some time to come. In making this assumption, the commission was on the safe side, as such conditions would require the greatest amount of energy.

The train resistance was calculated by applying the results of the latest and most reliable experiments to an average train consisting of 14 two-axle cars with a total weight of 160 tons. Taking everything into consideration, an average total train resistance of 12 pounds to the ton was fixed upon for the standard-gauge railways and 20 pounds to the ton for the narrow-gauge roads. The energy required for acceleration from a standstill up to the maximum speed was calculated, without subtracting anything for energy returned to the line when on a down grade, as it is not safe to count upon any such gain in regular practice.

In arriving at the weights of trains, they were divided into express trains, ordinary passenger trains and freight trains, and figures were found separately for the Swiss Federal Railways, the St. Gothard Railway, the remaining standard-gauge roads, and the narrow-gauge roads. The greatest passenger traffic is in August and the heaviest freight traffic in October, and the average and maximum figures for these months were determined. The summer weekday schedule was used for finding the maximum number of trains, and calculations were also made on the basis of the winter time-table.

All these fundamental quantities were very carefully worked out, so as to have the necessary data for determining the energy consumed during a day of 24 hours, and the maximum momentary power demanded at any one time. The great bulk of the energy is used in moving the trains along the main tracks, but, under certain circumstances, the amounts consumed in switching service, and in heating and lighting trains had also to be considered.

Under these conditions, it was found that the energy required for a day in summer at the driving axles of all the Swiss railways now operated by steam, amounted to 1,200,000 horse-power hours. In order to find the energy that would have to be furnished by the power stations, it was assumed that 40 per cent of that generated by the turbines would be available at the driving wheels of the trains. This would require the turbines to supply 3,000,000 horse-power hours per day, which would correspond to a rate of 125,000 horse power throughout the 24 hours. For a winter day, the figures are about 75 per cent of the above, and for an average day throughout the year, taking into account the absence of freight trains on Sundays, 80 per cent of the summer-day estimate. This would require a continuous delivery by the power stations of 100,000 horse power throughout the year.

With regard to the maximum momentary power demanded, it was found that there were wide variations in the load, particularly when only small sections of railroad were considered. By taking

larger sections, the inequalities were somewhat balanced, but a careful weighing of all the varying conditions showed that the maximum power required would be at least five times as great as the average. In designing the system of power distribution storage batteries would be utilized as far as possible to equalize daily fluctuations in the load, and in the development of the water powers, the storage capacity of reservoirs would be used to the fullest extent for equalizing the flow of water at different seasons, but even under the most favorable conditions it is estimated that the primary station capacity would have to be at least 500,000 horse power.

The commission will proceed to determine whether this amount of power is available, but it can be stated in advance that, whatever may be the final outcome of their investigations, the water powers of Switzerland will have to be carefully husbanded and their use in private enterprises restricted, if they are to inure to the highest welfare of the whole country.

NEW METHODS OF ELECTRIC LIGHTING.

RECENT IMPROVEMENTS IN THE TRANSFORMATION OF ELECTRICAL ENERGY INTO LIGHT, AND NEW TYPES OF LAMPS.

C. P. Steinmetz and C. H. Sharp—American Institute of Electrical Engineers.

FOR many years after the introduction of commercial electric lighting, by means of the carbon arc lamp and the incandescent lamp with a carbon filament, these illuminants reigned supreme, even although it was recognized that, as converters of electrical energy into light, their efficiency was very low. In the course of time, there have been many improvements in their manufacture, their cost has been greatly reduced and their life lengthened, but their inherent physical characteristics have prevented any great increase in their efficiency as light producers.

Many attempts were made to effect some radical improvement in them, or to displace them with other forms of electric light, but it was not until the introduction of the Nernst lamp several years ago that they had a commerical competitor, and even the Nernst lamp was found best fitted to occupy a position between the arc and the incandescent lamp, both in regard to candle power and to efficiency. Since then, however, there has been great activity among electric light inventors, and one lamp after another has been brought out, several of which have proved their practical value as well as their theoretical efficiency and give promise of seriously disputing the supremacy of the old arc and incandescent lamps, even if they do not crowd them off the field altogether.

At a recent meeting of the American Institute of Electrical Engineers the present state of the art of electric lighting was ably described in papers by Dr. Charles P. Steinmetz and Dr. Clayton H. Sharp and in the ensuing discussion, from which some extracts are here taken. Dr. Steinmetz devoted himself more particularly to the recent developments in arc lighting, although he reviewed the whole subject of the "Transformation of Electric Power into Light;" while Dr. Sharp's paper was on "New Types of Incandescent Lamps."

In lighting by incandescence, the luminous body is necessarily sending out not only visible rays, but radiations of all other frequencies, so that the ratio of the light rays to the total energy radiated, or the efficiency, is only a small fraction. This light efficiency becomes greater, the higher the temperature of the body, and in the crater of the carbon arc, which is at the temperature of boiling carbon, about 3,500° C., the highest efficiency of a simple incandescent body is reached, the light being produced at an expenditure of about half a watt per candle-power. But the large amount of energy which is conducted away by air currents and in other ways, reduces the actual efficiency of the carbon arc, so that it probably consumes about one watt per candle power.

"When producing light by passing an electric current through a carbon conductor, as in the incandescent lamp, no such efficiency can be reached. The higher the temperature of the incandescent-lamp filament,

the greater is the efficiency; but the limit of the temperature is not the boiling point of carbon, 3,500° C., but far below that; it is the temperature where evaporation of the filament becomes so rapid as to limit its life below economical requirements. This is probably not very far from 1,800° C.

"In the incandescent lamp, the problem of increasing the efficiency can be attacked in two ways. One way is to improve the carbon so as to prevent its evaporation. This has been accomplished in the 'metallized filament,' in which the carbon has undergone an allotropic modification which possesses pronounced metallic characteristics, and enables it to be run at a much higher efficiency, these lamps consuming only about 2.5 watts per candle.

"Another way is to replace the carbon by a material which has a lower vapor-tension at high temperature. While carbon has the highest boiling point, it is not the boiling point which is of importance in a lamp filament, provided that this point is sufficiently high—it is the vapor-tension far below this point.

"For instance, the metals osmium, tantalum, and tungsten (or wolfram) have a lower melting point or boiling point than carbon, but they have at the same high temperature a lower vapor-tension, owing possibly to their much greater atomic weight. These metals can be operated at a higher temperature than carbon, and as lamp filaments they give a much greater efficiency than the carbon filaments, about 2 watts per mean spherical candle-power for tantalum, 1.5 watts for osmium, and 1 watt per mean spherical candle-power for tungsten—compared with about 4 watts per mean spherical candle-power for the carbon-filament lamp."

The osmium lamp, in spite of its high efficiency and long life, seems precluded from exercising any revolutionary influence on lighting practice, on account of its low voltage and, most of all, by the limitations of the visible supply of the material of which the filament is composed. The other two, the tantalum lamp and the tungsten lamp, give greater promise of extensive use, and the latter, particularly, seems assured of a brilliant future.

Tantalum may be drawn directly into a filament, but tungsten, which is commercially obtainable in the form of a fine powder, does not seem to be ductile, and it unites readily with oxygen and with carbon at high temperatures. These peculiarities have made the problem of the production of a tungsten filament a difficult one, but different processes have been devised, which have been successful.

"The feature which differentiates the electrical behavior of the newer lamps from the ordinary carbon lamp is their positive temperature coefficient. The effect of this is to give the metal-filament lamps considerable inherent regulation. That is, the change of current through the lamp is no longer proportional to the change in voltage, but is smaller proportionally than the change in voltage. Consequently in watts, candle-power, and watts per candle of these lamps undergo smaller changes with the change in the line voltage than is the case of the carbon-filament lamp.

"It has been customary to consider as the useful life of a carbon-filament lamp its life up to the time when its candle-power has fallen to 80 per cent. of its initial value. Beyond this point it has been considered cheaper to discard the old lamp and replace it with a new one; in other words, this has been taken to be the proper 'smashing point' of the lamp. It should be pointed out that this relation does not hold with the metallic-filament lamps. The smashing point of a lamp is determined by considerations of initial cost of the lamp, the cost of electrical energy, and the rate of decline of the candle-power of the lamp. In the metallic filament lamps we have lamps of much higher economy, not only initially, but throughout their life, and as they are of relatively high initial cost, they are likely to be burned until they fail." They are of remarkably long life, one being cited which burned for over 3,500 hours, with a decrease in candle power of only about 10 per cent.

The color of the light from the tantalum lamp is whiter than that of the carbon filament lamp, and that from the tungsten lamp whiter still, resembling quite closely the quality of the acetylene flame. Extensive tests of tungsten lamps have shown that, under favorable circumstances, they consume only about one watt per candle, and this high efficiency, combined with their

long life and other good qualities make them the best all-around incandescent lamp thus far produced.

In the attempt to combine agreeable color with efficiency, various kinds of arc lamps have been tried, and among the most successful that have come into prominence recently are the flame carbon arc and the metal compound arc, the latter being one in which carbon is not used, but some material which gives a luminous spectrum, such as iron or titanium.

In the flame arc, the carbons are impregnated with some substance, such as calcium, which has a strong selective radiation, and whose vapor in the arc will shine with great brilliancy. These lamps have a glaring reddish yellow light, which is trying to the eyes, and which makes them more suitable for outdoor display purposes than for general illumination. As the impregnating substances deposit as solids after passing through the arc, ventilation must be provided to carry off this smoke, and the life of the carbons is short, high efficiency being obtained here, as in many other cases, at the expense of endurance.

"More prospect of success appears to exist in the true luminous arc, an arc using as negative a material giving an efficient and brilliant spectrum. Such material should give lines uniformly distributed not only in the green or yellow, but over the whole visible range, and the material should not be attacked in air, even at high temperature. The arc must be an open arc, since the material deposits as solid, and to get electrodes with long life, a material is required which is stable at high temperature in the air. There are very many metals which give luminous spectra, but those which give white are substantially the metals of the iron group only—iron, titanium, tungsten, etc.

"Long-burning quality requires a material which is not affected, or only little affected by the air. This, in general, excludes the metals, but requires a stable oxide or other fairly stable compound, as some carbides are. It should also be a conductor, since as arc electrode it has to carry the current. In the intermediate oxide of iron magnetite (Fe_3O_4), a material is found which is a good conductor, is stable at high temperatures as well as at low temperatures and gives a white spectrum. In such an electro-luminescent arc, any stable material is suitable as a positive terminal. Copper is generally used because it is cheap, is stable at fairly high temperature, is a very good conductor of heat, and when heated cient rapidity not to melt or oxidize appreciably. In all these arcs the vapor stream from the negative is a necessity.

"The amount of vapor produced by the current from the negative is usually many times greater than necessary to carry the current, and most of it can be condensed without any appreciable change in the arc-stream. So also magnetite consumes at a much greater rate than is necessary, of an order of ¼ gram per-ampere-hour. This rate of evaporation is greatly reduced by the addition of small quantities of a material which is chemically not much different from magnetite, but is much more refractory; so that at the temperature where the magnetite melts this material is still solid and forms a kind of sponge in which the melted magnetite is held and its consumption greatly retarded.

"Magnetite, however, while a good conductor of the arc-stream, is not very efficient as a producer of light, and added thereto are other materials which give a very high efficiency, such as titanium compounds.

"To conclude, then, in the luminous arc, we seem to have the first instance of a commercial application of a direct conversion of electric power into light, without heat as an intermediary form of energy, and not limited to very low values of efficiency. But so far it seems that only the green mercury spectrum, the yellow calcium spectrum, and the white titanium spectrum offer an efficiency so vastly superior to that of incandescent solids, that as regards the efficiency of light production no possible improvement in incandescent lighting could hope to approach it. Typical of these three most efficient spectra are the mercury-arc lamp, of practically infinite life and bluish-green color of light; the yellow flame carbon arc of the short life of the open arc-lamp of old; and the white titanium carbide or magnetite arc, of a life equal to or greater than that of the enclosed carbon arc."

THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE"

The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article.
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Progress in the Construction of Wide-Span, Flat, Heavy Bridges (Fortschritte im Bau Weitgespannter, Flacher, Massiver Brücken), Hr. Leibbrand. Abstract of address before the Association of German Architects' and Engineers' Societies, giving an illustrated review of the recent development of large masonry arches. Serial, 1st part. 2000 w. Beton u Eisen —No. 10. Oct. 1906. No. 80649 F.

Bascule.

The New Flushing Bascule Bridge. A bridge recently built over Flushing Creek, Long Island, is illustrated and described. 1000 w. Eng Rec—Nov. 10, 1906. No. 80328.

Blackwell's Island.

Progress on the Erection of the Blackwell's Island Bridge, New York. An

We supply copies of these articles. See page 679.

illustrated article giving information concerning recent work and the methods employed. 2800 w. Eng Rec—Nov. 3, 1906. No. 80260.

Cantilever.

Cantilever Bridge Over the Seine at Passy; Metropolitan Railway of Paris. R. Bonnin. Illustrated detailed description of this interesting new bridge and its approaching viaducts. 2500 w. Eng News—Nov. 15, 1906. No. 80443.

Foundations.

Methods and Costs of Constructing Two Concrete Foundations for Draw Bridges. Daniel J. Hauer. Gives details of two examples identically the same, but varying in cost. Ills. 2000 w. Engng-Con—Nov. 7, 1906. No. 80231.

New Orleans.

The New Orleans Railway Bridge, Elmer L. Corthell. An illustrated account of the physical, commercial and historical features of a project for a railway bridge over the Mississippi River. 4000 w. Eng Rec—Nov. 24, 1906. Serial. 1st part. No. 80575.

Piers.

A Problem Relating to Railway-Bridge Piers of Masonry or Brickwork. Frederick Carl Esling. An investigation of stresses resulting in certain cases from the combined action of the horizontal and vertical forces. 2500 w. Inst of Civ Engrs—No. 3592. No. 80537 N.

Design of a Railway Bridge Pier. Charles Derleth, Jr. An illustrated statement of the methods of design of a bridge and caisson. 7800 w. Cal Jour of Tech—Nov. 1906. No.80410.

Railway Curves.

Railway Bridges on Curves (Eisenbahnbrücken in Gleiskrümmungen). Leopold Oerley. Mathematical and general discussion of stresses and design. 1st plate. 6500 w. Oest Wochenschr f. d. Oeff Baudienst—Oct. 20, 1906. No. 80612 D.

Reinforced Concrete.

The Walnut Lane Bridge, Philadelphia. An unusually large and beautiful bridge of reinforced concrete construction is illustrated and described. It is designed for highway traffic. 1200 w. Eng Rec—Nov. 17, 1906. No. 80506.

Rome.

The Victor Emmanuel Bridge Over the Tiber, at Rome (Die Viktor Emanuel Brücke über den Tiber in Rom). Julius Stanek. Abstract from "Annali della Societa d. Ingegneri e d. Arch. Italiani," giving illustrated description of masonry arch bridge. 2 plates. 1600 w. Oest Wochenschr f d Oeff Baudienst—Nov. 10, 1906. No. 80615 D.

Transporter-Bridge.

The Widnes and Runcorn Transporter-Bridge. John James Webster. Illustrated detailed description of this bridge and its equipment, methods of erection and cost. Abstract of discussion. Plates. 31000 w. Inst of Civ Engrs—No. 3534. No. 80534 N.

Viaduct.

Concrete Viaduct. Illustrated description of the Santa Ana arched viaduct in California. No steel nor stone masonry was used in its construction. 1000 w. Ry & Loc Engng—Nov. 1906. No. 80225 C.

Viaduct Cost.

Graphical Determination of the Most Economical Method of Crossing a Valley (Zeichnerische Bestimmung der Wirtschaftlich Vorteilhaftesten Anordnung einer Talübersetzung). Dr. Robert Schönhöfer. Comparison of costs of different kinds of viaducts by means of diagrams. 1 plate. 1200 w. Oest Wochenschr f d Oeff Baudienst—Oct. 27, 1906. No. 80613 D.

CONSTRUCTION.

Automobile Shops.

The Cadillac and Packard Automobile Shops of Reinforced Concrete. A 90x 300 ft. factory building, having three floors and a basement, recently completed in Detroit, Mich., is illustrated and described. 1700 w. Eng Rec—Nov. 17, 1906. No. 80507.

Concrete.

Reclaiming the Deserts by Concrete. Day Allen Willey. Describes the great irrigation works under construction in Nevada and Arizona, which include concrete dams, channels, and tunnels at a cost of millions. Ills. 1500 w. Cement Age—Nov, 1906. No. 80416.

A Surface Finish for Concrete. Henry H. Quimby. Describes the writer's method of obtaining an artistic concrete surface, giving illustrations showing the variety obtained with different aggregates. 1400 w. Cement Age—Nov., 1906. No. 80417.

Cost of Concrete Superstructure, West Pier, Charlotte Harbor, N. Y. Gives illustration showing the adopted design, and the cost of the work as given in the report of the Chief of Engineers of the U. S. Army. 1000 w. Eng News—Nov. 15, 1906. No. 80449.

Culvert.

The Ouseburn Culvert. Illustrates and describes an interesting engineering work in progress at Newcastle-on-Tyne. It consists in culverting the Ouseburn and filling up the valley to improve the communication between Newcastle and Heaton. 1400 w. Engr, Lond—Nov. 2, 1906. No. 80361 A.

Dams.

See Civil Engineering, Waterways.

We supply copies of these articles. See page 679.

Earthquakes.

Building in Earthquake Countries. M. Montessus de Ballore. Considers the principles governing the art of building in countries subject to earthquakes. 1700 w. Am Archt—Nov. 10, 1906. Serial. 1st part. No. 80320.

Fireproof.

Steamship Terminal with Fireproof Warehouses; New Orleans Terminal Ry. Plans and brief description of the fireproof construction for the sheds at Chalmette, near New Orleans. 1000 w. Eng News—Nov. 22, 1906. No. 80557.

Foundations.

Allowable Pressures on Deep Foundations. Elmer Lawrence Corthell. A report of investigations made by the writer. 1000 w. Inst of Civ Engrs—Abstract of paper No. 3598. No. 80536 N.

The Foundations of the Trinity Annex and Boreel Buildings, New York. Explains the change made in the location of Thames St., New York, and the method of constructing the foundations for new buildings on Broadway, near Wall St. 3500 w. Eng Rec—Nov. 3, 1906. No. 80261.

See also Civil Engineering, Bridges.

Hotels.

The Construction of the Hotel Traymore at Atlantic City, N. J. Illustrated description of a building constructed on the site of an old hotel and adjacent property, without interrupting the hotel business. Reinforced concrete and hollow tile construction is employed. 2200 w. Eng Rec—Nov. 10, 1906. No. 80327.

Construction of the New Plaza Hotel, New York. Brief illustrated account of the removal of the old Plaza, and the construction of the 18-story, steel-cage, fireproof structure now in progress. 2200 w. Eng Rec—Nov. 17, 1906. No. 80510.

Reinforced Concrete.

A New Method of Reinforced Concrete Wall Construction. A. E. Budell. Describes methods used in constructing a machine shop at Old Bridge, N. J. 800 w. Engng-Con—Nov. 28, 1906. No. 80733.

French Rules on Reinforced Concrete. Translated report of the official instructions just issued by the ministry of public works to govern the use of this material in France. 6500 w. Cement Age—Nov, 1906. No. 80418.

Heat Treatment of Reinforced Concrete. H. B. Macfarland. Gives details of tests made at the Chicago laboratory of the National Fire Proofing Company, to determine the fireproof value of reinforced-concrete columns. 1700 w. Engr, U S A—Nov. 1, 1906. No. 80202 C.

Reinforced Concrete in the San Francisco Fire: The Johnson Building. Gives the statement by A. L. A. Himmelwright in regard to the Johnson Building, and a letter from C. F. Wieland claiming the failure was due to defective design. Ills. 2000 w. Eng News—Nov. 8, 1906. No. 80333.

The Calculation of Concrete Slabs with Iron Reinforcement (Beitrag zur Berechnung von Betonplatten mit Eiseneinlagen). Prof. G. Ramisch. Mathematical discussion, with diagram, of concrete, flat on top and vaulted underneath, with straight iron reinforcement. 1000 w. Zeitschr d Oest Ing u Arch Ver—Oct. 26, 1906. No. 80622 D.

The Calculation of Reinforced Concrete Structures with Eccentric Loading (Die Berechnung von Eisenbeton-Konstruktionen bei Excentrisch Wirkender Normalkraft). Hr. Landmann. Mathematical discussion, with diagrams. Serial. 1st part. 1000 w. Beton u Eisen—No. 10, Oct., 1906. No. 80650 F.

The Undosa Bath at Starnberg (Das Undosa-Wellenbad in Starnberg). G. Schellenberger. Illustrated description of large bathing establishment, where waves are produced artificially, and of restaurant, at Starnberg Lake, in Bavaria. The construction is mainly in reinforced concrete. 21 plates. Serial. 1st part. 2000 w. Beton u Eisen—No. 10, Oct., 1906. No. 80648 F.

Trusses of Reinforced Concrete (Fachwerkträger aus Eisenbeton). S. Zipkes. Illustrated description of lattice girders, bridges and other framework structures whose members are of reinforced concrete. 1 plate. Serial. Part 1. 2000 w. Beton und Eisen—No. 10, Oct., 1906. No. 80647 F.

Cement Beton Shop Floors and Beams. Robert Grimshaw. Illustrates the use of this material in the form of slabs laid between or across the beams, and other developments of this idea. 700 w. Ir Trd Rev—Nov. 1, 1906. No. 80163.

Ferro-Concrete Coal Wharf at Rochester. Illustrated description of an extensive coal wharf in course of construction in England, as a typical illustration of the application of ferro-concrete to wharf design. 3000 w. Engng—Nov. 16, 1906. No. 80726 A.

See also Civil Engineering, Bridges.

Roads.

I. A Plea for Better Country Roads. George Robert Jebb. No. 3624. II. Country Roads for Modern Traffic. John Eaton Blackwall. No. 3604. Two papers discussed together. Ills. 33000 w. Inst of Civ Engrs—Feb. 20, 1906. No. 80545 N.

The Construction of Low-Cost Country Roads. Reviews information given by W. W. Crosby, chief engineer of the highway division of the Maryland Geological survey, concerning the cost of

road construction, and the materials used. 2500 w. Eng Rec—Nov. 10, 1906. No. 80325.

The Construction of Sand-Clay and Burnt-Clay Roads. From a report by W. L. Spoon on some experimental roads constructed of these materials. 2000 w. Eng Rec—Nov. 17, 1906. No. 80511.

The Construction of Sand-Clay and Burnt-Clay Roads. From a discussion by William L. Spoon, on the construction of such roads. 1400 w. Eng News—Nov. 1, 1906. No. 80183.

The Use of Tar on Roads. James Owen. From a paper before the Am. Soc. of Munic. Imp. Gives a brief outline of what has been attempted in Europe and America in the application of tar and crude oil to the surface of roads to prevent dust. 2000 w. Munic Engng—Nov., 1906. No. 80216 C.

Roofs.

Saw-Tooth Roofs for Factories. Knight C. Richmond. Describes this form of roof-lighting, considering its aims advantages, construction, design, etc. Ills. 4000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80524.

Settlement.

The Remarkable Settlement of a Concrete Building in Tunis. P. Fountain. Illustrates and describes an examole of settlement of a large building built on marshy ground, and the restoration to the vertical position. 800 w. Eng Rec—Nov. 3, 1906. No. 80263.

Tall Buildings.

Some Structural Features of the City Investing Company's Building, New York. Illustrated notes concerning a 32-story building, rising to a height of 486 feet above the sidewalk, under construction in the Wall St. district. 3000 w. Eng Rec—Nov. 24, 1906. No. 80574.

Tunnels.

Progress on the Manhattan Work of the Pennsylvania, New York & Long Island R. R. An illustrated article describing the tunnel work in progress under 32d and 33d Sts., Manhattan, which will connect the East River tunnels with the great terminal station. 4000 w. Eng Rec—Nov. 10, 1906. No. 80324.

The Pennsylvania Tunnels Across Manhattan Island. Illustrates and describes the methods and plant used in driving the tunnels under 32d and 33d streets from the shafts at First avenue to the terminal station at Seventh avenue. The double-track tunnel is being driven through rock without disturbing the surface. 2200 w. R R Gaz—Nov. 2, 1906. No. 80203.

Railway Tunnels to Manhattan Island. Information of interest concerning the 14 subaqueous tubes under construction to connect Manhattan Island with Long Island and New Jersey. Ills. 2500 w. Elec Ry Rev—Nov., 1906. No. 80421.

The Channel Tunnel Project. Abstract Translation from *Génie Civil*, discussing the best means of effecting the transit of the channel between England and France other than the methods in use. Describes the project proposed by the French. 2200 w. Engr, Lond—Nov. 9, 1906. No. 80500 A.

The Kaw River Tunnel of the Kansas City Water Works. C. K. Allen. Illustrated detailed description of the construction of this tunnel. 3000 w. Eng Rec—Nov. 17, 1906. No. 80504.

Waterproofing.

Mistakes in Waterproofing. Edward W. De Knight. Read before the Am. Soc. Test. Mat. Discusses the importance of design, the use of proper materials, and their application. 3000 w. Cement Age—Nov., 1906. No. 80420.

MATERIALS OF CONSTRUCTION.

Bricks.

Tests and Theories in Their Relation to Specifications for Bricks. Jos. A. Shinn. Gives a report of tests, with explanatory remarks and discussion of the qualities of various kinds of bricks. 3000 w. Pro Engrs' Soc of W Penn—Nov., 1906. No. 80232 D.

Cement.

Constancy of Volume in Portland Cement. A résumé is given as the result of study by E. D. Campbell, and A. H. White at the University of Michigan. Gives conclusions of value to users of cement in industrial work. 1100 w. Min Rept—Nov. 22, 1906. No. 80595.

Cement Laboratory.

The Lesley Cement Laboratory, University of Pennsylvania. An illustrated description of this laboratory for instruction in standard cement testing and for research in concrete work. 1500 w. Eng Rec—Nov. 3, 1906. No. 80262.

The Lesley Cement Laboratory. Edgar Marburg. Illustrated detailed description of this feature of the new building for the engineering departments of the University of Pennsylvania. 2000 w. Cement Age—Nov., 1906. No. 80419.

Concrete.

Concrete and Concrete Work. Ernest McCulloch. The present article considers reinforced concrete as a building material. 1400 w. Mfrs' Rec—Nov. 8, 1906. Serial. 1st part. No. 80271.

Corrosion.

The Corrosion of Reinforcing Metal in Cinder-Concrete Floors. Report of a committee appointed to investigate examples of serious corrosion of this material, found at San Francisco. 2800 w. Eng News—Nov. 1. 1906. No. 80181.

Reinforced Concrete.

See Civil Engineering, Construction.

We supply copies of these articles. See page 679.

Road-Making Stones.

Attrition Tests and Petrological Descriptions of British Road-Making Stones. Some valuable information from a book recently published in London, concerning the characteristics and availability of different broken stones of possible use for road-making. 1200 w. Eng News—Nov. 15, 1906. No. 80450.

Stone.

The Strength of Stone as Affected by Different Methods of Quarrying. Francis W. Hoyt. Discusses the usual methods of testing and why the information is misleading, the effects of quarrying and dressing, etc. 3000 w. Eng News—Nov. 1, 1906. No. 80176.

MEASUREMENT.

Backwater.

The Computation of Height of Backwater Above Dams. D. M. Andrews. The methods employed by the writer are given. 1000 w. Eng News—Nov. 1, 1906. No. 80179.

Beams.

Economical Proportions in I-Beam Sections. Robert H. Smith. A study of the economic proportions between web thickness and flange width, flange thickness and total depth, and variation of total depth throughout the span length. 3500 w. Engr, Lond—Nov. 9, 1906. No. 80499 A.

Earthwork.

Preliminary Earthwork Estimation with the Slide Rule. C. W. Crockett. An explanation of the method used, illustrating by example. 1500 w. Eng News—Nov. 15, 1906. No. 80448.

Framework.

Resistance to Buckling of a Three-Armed Plane System (Knickfestigkeit eines Dreiarmigen Ebenen Systems). L. Vianello. Mathematical discussion of stresses and strains in a framework consisting of three straight members meeting at a point. Diagrams and table. 1000 w. Zeitschr d Ver Deutscher Ing—Oct. 27, 1906. No. 80606 D.

Resistance Moments.

Defective Resistance Moments (Fehlerhafte Widerstandsmomente). F. Kliewer. A discussion of the changes in the moments of resistance of beams of various sections caused by introducing thin plates. Formulae and diagrams. 500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 19, 1906. No. 80621 D.

Sounding.

Bathometer, Its Construction and Use. E. S. Wheeler. Illustrates and describes this sounding apparatus and its uses. 2000 w. Marine Rev—Nov. 15, 1906. No. 80428.

Ratio.

Some Problems in Ratio. A. J. Dixon. How to apply the principles governing ratio to the solution of engineering problems. 1200 w. Engr, U S A—Nov 15, 1906. No. 80436 C.

MUNICIPAL.

Earth Settlement.

Earth Settlement in City Streets. Horace Andrews. From a paper before the Am. Soc. of Munic. Imp. Gives a summary of the best practice in dealing with the shrinkage and expansion of soils in different climates, and related matters. 4500 w. Munic Engng—Nov., 1906. No. 80217 C.

New Orleans.

Sanitary Conditions in New Orleans. George G. Earl. Read before the Am. Soc. of Munic. Imp. Briefly outlines the history of this city and conditions affecting the health and needed sanitary improvements, describing work already accomplished and in progress. 2500 w. Munic Engrg—Nov., 1906. No. 80215 C.

Pavements.

Bituminous Pavements Containing Crushed Stone. J. W. Howard. Considers bituminous pavements for cities and their construction. 2800 w. Munic Engng—Nov., 1906. No. 80218 C.

Tests of Other Woods Than Yellow Pine for Pavements. F. A. Kummer. Gives information concerning tests made and results obtained with various woods in determining their value for paving purposes. 3500 w. Munic Engng—Nov., 1906. No. 80219 C.

Sewage.

Notes on the Septic Tank Process of Sewage Purification. W. R. Butler. A discussion of this process with notes on the history of its development. 5000 w. Can Soc of Civ Engrs—Adv. Proof, Nov., 1906. No. 80205 D.

The Baltimore Sewage Testing Station. Illustrates and describes the experimental station under construction. It comprises a septic tank, sprinkling filters, and a laboratory. 1500 w. Eng Rec—Nov. 17, 1906. No. 80509.

The Relation of the Suspended Matter in Sewage to the Problem of Sewage Disposal. Harrison P. Eddy and Almon L. Fales. Gives some of the results of the practical operation of various methods of sewage purification at the disposal works in the city of Worcester, Mass. Ills. Discussion. 18000 w. Jour Assn of Engng Socs—Sept., 1906. No. 80548 C.

The Treatment and Disposal of Sewage. John D. Watson. Condensed paper, read before the annual congress of the Inc. San. Assn. of Scotland. Discusses the oxidation and nitrification of septic tank liquor, the design of percolating filters and settling tanks. 3800 w. Eng News—Nov. 1, 1906. No. 80178.

Fungus Growth on Experimental Percolating Sewage Filters at Waterbury,

Conn. Leo F. Rettger. Describes briefly the experimental plant, and the growth that appeared, its character and the methods tried for its removal. 1200 w. Eng News—Nov. 1, 1906. No. 80182.

Sewers.

Methods and Costs of Constructing a Section of Brick Sewer, the Tunnel Method of Excavating Being Used. Information and drawings relating to a sewer in Syracuse, N. Y. 3500 w. Engng Con—Nov. 14, 1906. No. 80364.

WATER SUPPLY.

Analysis.

Water Analysis for Steam Users. John B. C. Kershaw. The present number considers the sources of natural water supply and the physical and chemical characteristics as far as they have any bearing upon the use of such waters for steam-raising. 2500 w. Mech Engr—Nov. 10, 1906. Serial. 1st part. No. 80474 A.

Aqueduct.

Details of the Catskill Aqueduct, New York. Illustrates and describes portions of this great conduit and the general method of construction to be followed. 2000 w. Eng Rec—Nov. 10, 1906. No. 80326.

Charleston.

New Water Supply for Charleston, S. C. J. W. Ledoux. Gives a brief historical review of the water supply from the earliest settlement of Charleston, and explains why the Goose Creek supply was decided upon. Also a description of the water-works plant, and other information. Ills. 5000 w. Pro Engrs' Club of Phila—Oct., 1906. No. 80233 D.

Cleveland, O.

The Quality of the Water Supply of Cleveland, O. George C. Whipple. A résumé of report made to the Water Department concerning an investigation of the quality of the water of Lake Erie in the vicinity of Cleveland. 6500 w. Eng Rec—Nov. 10, 1906. No. 80323.

Filtration.

The Water Filter of the Jacob Tome Institute. Illustrated description of this filtration plant at Port Deposit, Md. 2500 w. Eng Rec—Nov. 24, 1906. No. 80576.

High Water.

The Utilization of High Water at Water Power Plants (Die Ausnutzung von Hochwasser bei Wasserkraftanlagen). H. E. Gruner. Illustrated description of experiments at Chèvres, on the Rhone, and Vessy, on the Arve, to lower the water level in the tail race, by manipulating the sluice gates, at times of high water. Tables. 800 w. Zeitschr d Ver Deutscher Ing—Nov. 10, 1906. No. 80617 D.

Irrigation.

Water Rights and Irrigation in Canada and the United States, with the Lessons to be Derived Therefrom for the Dutch East Indies (Waterrechten en Irrigatiewetgeving in Canada en de Vereenigde Staten van Noord-Amerika en Lessen te Trekken voor Nederlandsch Indie). R. A. van Sandick. General review. 5000 w. Ingenieur—Oct. 27, 1906. No. 80646 D.

Irrigation in the Transvaal. Michael Richard Collins. Considers problems in connection with this work, deducing the run-off, flood, discharge, and duty which appear to be applicable in the design of storage-reservoirs, etc. Describing also some existing Government works. Ills. 5000 w. Inst of Civ Engrs—No. 3622. No. 80544 N.

The Construction of Irrigation Works by the U. S. Reclamation Service. Reviews past work and the large projects now being carried out, especially the Truckee-Carson project. 2800 w. Eng News—Nov. 1, 1906. No. 80184.

See also Civil Engineering, Construction.

Peru.

The Water Powers of Peru. Their Development and Possible Applications. Emile Guarini. A general outline of the opportunities, the principal streams adapted to immediate utilization, the existing plants and markets for power, and the proposed scheme for developing power from Lake Titicaca. 2500 w. Engineering Magazine—Dec., 1906. No. 80697 B.

Pollution.

Stream Pollution by Acid-Iron Wastes; and the Sewage Works at Shelby, Ohio. Reviews a recent report by Herman Stabler on behalf of the U. S. Gov. Surv., and the Ohio State Board of Health, giving the final summary. 1500 w. Eng News—Nov. 22, 1906. No. 80558.

Reservoirs.

The Cost of Cleaning and Grubbing a Reservoir Site. Julian Griggs. Gives details of cost of cleaning and grubbing the site of the reservoir formed by the construction of the Scioto River Storage dam for the municipal water supply for Columbus, Ohio. 3000 w. Munic Engng—Nov., 1906. No. 80214 C.

Sterilization.

The Use of Ozone for the Sterilization of Water. Illustrates and describes a transportable ozone plant, and other arrangements of the apparatus to meet industrial requirements. 1400 w. Prac Engr—Oct. 26, 1906. No. 80296 A.

Tank.

A Large Water Tank With Vertical Bracing and Top Stiffening Ring. Illustrates and describes an unusually large tank at Rochester, N. Y. 500 w. Eng News—Nov. 15, 1906. No. 80446.

We supply copies of these articles. See page 679.

Typhoid Fever.

I. The Prevalence and Causation of Typhoid Fever in Washington, D. C. Theodore Horton. II. Comments Upon Mr. Horton's Report Upon the Typhoid Fever Situation in the District of Columbia. William T. Sedgwick. The first gives the results of a careful study of the situation. Also editorial on the two papers. 10500 w. Eng News—Nov. 8, 1906. No. 80335.

Underground Water.

The Flow of Underground Water. William Ralph Baldwin-Wiseman. Experimental research work made to investigate the relationship between the porosity of a rock and the flow of water through its interstices, under various pressures. 7000 w. Inst of Civ Engrs—No. 3594. No. 80533 N.

WATERWAYS AND HARBORS.

Amsterdam.

The Improvement of the North Sea Canal (De Verbetering van het NoordzeeKanaal). H. Wortman. Well illustrated description of the widening and deepening of the canal from Amsterdam to the North Sea, and of its bridges, locks, etc. 7000 w. Ingenieur—Oct. 20, 1906. No. 80644 D.

Blasting.

Blasting Out a Reef in New York Harbor. Brief description of methods used in unusually difficult work in New York harbor. Ills. 900 w. Sci Am—Nov. 24, 1906. No. 80593.

Colorado River.

Colorado River Crevasse and Salton Sea—The Great Work of Control. A short account of the methods tried for restoring to its natural bed the Colorado River, which for two years has been flowing into the Salton basin, and the final success. Maps. 1800 w. Ry Age—Nov. 2, 1906. No. 80238.

Dams.

The Largest Movable Dam of the Beartrap Type in the Country. W. C. Weeks. Illustration, with brief description and history of this dam on the Spokane River, at Post Falls, Idaho. 1200 w. Elec Rev, N. Y.—Nov. 3, 1906. No. 80253.

The Mercedes Dam, Mexico. James D. Schuyler. Illustrated description of a dam nearing completion near Pasaje, Durango, Mexico. It was built largely by hand labor. 2800 w. Eng News—Nov. 1, 1906. No. 80175.

Docks.

The Construction of the Seaham Harbor Dock-Works. Percy Tillson Gask. Illustrated description of the construction of a new dock and protective piers. 4000 w. Inst of Civ Engrs—No. 3607. No. 80540 N.

Repairs to Dock Walls. Frederick James Rigg. Brief description of the repairs to the Humber Dock at Hull, England. 400 w. Inst of Civ Engrs—No. 3618. No. 80542 N.

Dredging.

Dredging New Haven Harbor. Edwin S. Lane. Describes the modern methods of dredging used in this work, using a pump dredge, which is illustrated. 1500 w. Yale Sci M—Nov., 1906. No. 80567 C.

A Huge and Interesting Dredging Plant for Service in India. Illustrates and describes the dredge "Foyers." The bow is of triple form, constituting two wells in which rotary cutters are mounted for excavating hard material. 1500 w. Sci Am Sup—Nov. 3, 1906. No. 80187.

Germany.

See Industrial Economy.

Hodbarrow Mines.

The Outer Barrier, Hodbarrow Iron Mines, Millom, Cumberland. Harry Shelford Bidwell. Describes the conditions at these mines, and the method of dealing with very difficult work. Abstract of discussion. Plates. 26000 w. Inst of Civ Engrs—No. 3565. No. 80535 N.

Panama.

General Plan for the Construction of the Panama Canal. Gives the substance of a recent circular for the information of bidders. Gives the schedule of quantities involved in the work. 1500 w. Eng News—Nov. 8, 1906. No. 80337.

Changes in the Form of the Contract for Completing the Panama Canal. Calls attention of bidders to important changes in the contract as given in a recently issued circular by T. P. Shonts. 900 w. Eng News—Nov. 8, 1906. No. 80332.

Present Conditions at Panama. An illustrated article explaining the general plan of construction, and commenting on earlier work. Also editorial. 4000 w. Sci Am—Dec. 1, 1906. No. 80737.

River Channels.

Treatment of Rivers with Shifting Channels. Reviews the German and French methods of dealing with rivers of this class, describing work on the Rhone and the Loire. 2000 w. Engr, Lond—Nov. 2, 1906. No. 80362 A.

Royal Commission.

Royal Commission on Canals and Waterways. Describes the work of the Commission appointed to inquire into the canals and inland navigations of the United Kingdom and report their present condition and financial position, and matters relating to their improvement and extensions. 3000 w. Engng—Nov. 2, 1906. Serial. 1st part. No. 80355 A.

St. Nazaire.

The New Entrance to the Port of St. Nazaire (La Nouvelle Entrée du Port de Saint Nazaire). E. Aragon. Well illustrated description of harbor at the mouth of the Loire, with tide lock, inner and

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outer basins, bridges, etc. 2 Plates. Serial. 2 parts. 6000 w. Génie Civil—Oct. 20 and 27, 1906. No. 80626 each D.

Spurdikes.

Bank Protection on the Lower Mississippi by Means of Spurdikes (Uferbefestigung am Unteren Mississippi mit Spurdikes). A. v. Horn. Illustrated description of cribwork sunk at right angles to bank. 1 plate. 600 w. Oest Wochenschr f d Oeff Baudienst—Oct. 27, 1906. No. 80614 D.

MISCELLANY.

Caisson-Disease.

Caisson-Disease at the New High-Level Bridge, Newcastle-on-Tyne. George Walter Morgan Boycott. Explains the cause of the disease, the conditions at Newcastle and the medical lock provided. 2000 w. Inst of Civ Engrs—No. 3609. No. 80541 N.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio Telegraphy.

Apparatus for Protecting Radio-Telegraphic Apparatus from the Influence of Electric Discharges (Appareil de Sécurité Contre les Etincelles Accidentales dans les effets de Télémecanique sans Fil). Edouard Branly. Description of automatic circuit breaker. 8000 w. Comptes Rendus—Oct. 22, 1906. No. 80641 D.

The Large Radio-Telegraphic Station at Nauen (Die Funkentelegraphische Grossstation Nauen). Hr. Siewert. Illustrated description of a powerful station near Berlin with tower 330 feet high, on the "telefunken" system. 1500 w. Elektrotech Zeitschr—Oct. 18, 1906. No. 80651 B.

The High-Power Wireless Telegraph Station at Nauen, Near Berlin. Illustrates and describes a long-range station working on the "Telefunken" system. 1500 w. Elect'n, Lond—Nov. 2, 1906. No. 80354 A.

A "Wireless" Station for Long-Distance Communication. Illustrated description of an important installation at Nauen,, Germany, having several novel features. 1000 w. Elec Rev, Lond—Nov. 16, 1906. No. 80716 A.

The Tuning of Radio-Telegraphic Transmitters (Ueber die Abstimmung Funkentelegraphischer Sender). A. Slaby. The closing instalment of a discussion with Max Wien. 3000 w. Elektrotech Zeitschr—Oct. 18, 1906. No. 80653 B.

The Development of Wireless Telegraphy (Die Entwicklung der Drahtlosen Telegraphie). Dr. Adolf Franke. Address before the Elektrotechnische Verein, giving an illustrated general review and account of present state of art. 5000 w. Elektrotech Zeitschr—Oct. 25, 1906. No. 80656 B.

Departures from Ohm's Law, Rectifying Action and Wave Detectors in Wireless Telegraphy (Ueber Abweichungen vom Ohmschen Gesetz Gleichrichter-Wirkung und Wellenanzeiger der Drahtlosen Telegraphie). H. Brandes. Discussion of conductors which do not obey Ohm's law, and which on account of their current-rectifying effect can serve as wave detectors. Diagrams and formulas. 2000 w. Elektrotech Zeitschr—Nov. 1, 1906. No. 80658 B.

A Method for the Production of Undamped Electrical Oscillations and its Application in Wireless Telegraphy (Ein Verfahren zur Ergeugung Ungedämpfter Elektrischer Schwingungen und Seine Anwendung in der Drahtlosen Telegraphie). Valdemar Poulsen. Address giving an illustrated description of transmitter with an electric arc in a hydrogen atmosphere. 3000 w. Elektrotech Zeitschr—Nov. 8, 1906. No. 80663 B.

Wireless Telegraphy by Means of Undamped Oscillations. Valdemar Poulsen. Abstract of a lecture before the Elektrotechnische Verein. An account of an interesting system of producing undamped oscillations, with W. D. Duddell's researches on the "singing arc" as a basis. 1200 w. Elec Rev, Lond—Nov. 16, 1906. No. 80715 A.

Communications on Wireless Telegraphy. J. Hettinger. Brief explanation of a receiving arrangement for utilizing the energy induced by the two waves of coupled transmitters. 300 w. Elec Engr, Lond—Oct. 26, 1906. No. 80302 A.

The Carborundum Wireless Detector. Greenleaf W. Pickard. Description of a detector, consisting essentially of a carborundum fragment, and of its mode of operation. Developed by Gen H. H. C. Dunwoody. 900 w. Elec Wld—Nov. 24, 1906. No. 80589.

The Wireless Telegraph Conference. An authoritative account of the work at the recently concluded conference at Berlin. 1500 w. Elec Rev, Lond—Nov. 16, 1906. No. 80717 A.

Radio-Telephony.

Experiments with Radio-Telephony. (Versuche mit Elektrischem Fernsprechen ohne Draht). Ernst Ruhmer. Illustrated

description of experiments using an arc transmitter and electrolytic receiver. 800 w. Elektrotech Zeitschr—Nov. 15, 1906. No. 80666 B.

Telegraphy.

Multiplex Telegraphy and Simultaneous Telegraphy and Telephony. William Maver, Jr. Explains the principles involved, illustrating by diagrams. 1800 w. Cassier's Mag—Dec., 1906. No. 80751 B.

Telephony.

Automatic Telephony (Das Automatische Telephon). Ernst Kronstein. Amplification of an address giving a general review of the various systems. Diagrams. Serial. 3 parts. 3500 w. Elektrotech u Maschinenbau—Oct. 28, Nov. 4 and 11, 1906. No. 80672 each D.

On the Measurement of the Constants of Telephone Lines. Béla Gáti. Gives a combination of the barretter method of measuring currents with the three-ammeter method of measuring power. 800 w. Elect'n, Lond—Nov. 2, 1906. No. 80353 A.

The Evolution of the Telephone. J. H. Winfield. A brief sketch of the changes and improvements in telephone apparatus, and the enormous development of the telephone business. 3000 w. Can Elec News—Nov., 1906. No. 80453.

Wires.

Standard Conditions and Specifications for Telephone or Other Low Tension Wires Crossing Railway Tracks. Given by E. E. Parsons in a paper read before the Assn. of Ry. Tel. Supts. In use by the Bell Telephone Co. of Canada. 1800 w. Eng News—Nov. 15, 1906. No. 80444.

DISTRIBUTION.

Cables.

Electric Cable Troubles. J. H. C. Brooking. Discusses the design of cables, the laying and joining, and the maintenance, and some of the troubles due to faulty work in all of these stages. 4000 w. Cassier's Mag—Dec., 1906. No. 80748 B.

Three-Phase Power Transmission by Underground Cables. Alfred Still. Aims to show how the line losses and capacity effects in a three-core underground cable can be approximately predetermined. 3000 w. Elec Engr, Lond—Nov. 16, 1906. No. 80712 A.

London.

London Power Scheme. James Lawrence. Outlines the main features of a scheme for supplying electrical energy to London and adjacent districts. 2000 w. Elec Wld—Nov. 24, 1906. No. 80591.

Phase Changing.

Single-Phase Currents from Three-Phase Supply. Alfred Still. Deals with the relative efficiencies of alternative arrangements involving the use of one, two or three-phase windings on the primary side of transformers. 2500 w. Elect'n, Lond—Nov. 9, 1906. No. 80482 A.

Phase Shifting.

The Production of a Shifting of Phase of 90° by Means of Inductance Alone (Die Erzeugung einer Phasenverschiebung von Genau 90° Durch Blosse Induktion). Dr. E. Müllendorff. The mutual inductance of two branch circuits is used besides their self-inductance. Formulæ. 200 w. Elektrotech Zeitschr—Nov. 15, 1906. No. 80667 B.

Switchboard.

A Switchboard Attachment for Eletrolysis. E. L. Larison. Describes an arrangement, built entirely at a technical laboratory, which has given excellent results. Ills. 600 w. Eng & Min Jour—Nov 7, 1906. No. 80441.

ELECTRO CHEMISTRY.

Battery.

A New Primary Battery for Large Currents. Carl Hering. Remarks at the meeting held Oct. 18, 1906, on the Decker Primary Battery, an interesting form of battery for relatively large outputs. 2000 w. Jour Fr Inst—Nov., 1906. No. 80406 D.

Electroplating.

"Spotting Out" of Electroplated Work; Its Cause and Remedy. Considers the trouble due to imperfect castings, and caused by liquid in the cavities of the metal gradually oozing out after the deposit has been put on. The remedy is to remove the liquid in the pores. Ills. 2200 w. Brass Wld—Nov., 1906. No. 80515.

Sodium.

The Extraction of Metallic Sodium. C. E. Carrier, Jr. Aims to present a more complete bibliography of this subject than has previously been published, together with brief descriptions, which will make it a history of the art. 4300 w. Elec-Chem & Met Ind—Nov., 1906. Serial. 1st part. No. 80425 C.

Storage Batteries.

Recent Storage Battery Improvements. Sherard Cowper-Coles. Read before the Soc. of Engrs. Considers electrodes that retain a large quantity of the electrolyte in themselves, and in which the active material is not necessarily porous. 3000 w. Elec Engr, Lond—Nov. 9, 1906. Serial. 1st part. No. 80480 A.

See also Electrical Engineering, Generating Stations.

ELECTRO PHYSICS.

Air Conductivity.

The Conductivity of Air in an Intense Electric Field and the Siemens Ozone Generator. Arthur W. Ewell. Presents results obtained by the author, describing the investigations. 2500 w. Am Jour of Sci—Nov., 1906. No. 80162 D.

Armature Flux.

The Distribution of Magnetic Flux in the Armature of a Direct Current Machine (Die Verteilung der Magnetischen Kraftlinien im Anker einer Gleichstrommaschine). Dr. J. v. Studniarski. Experimental investigation, showing that the maximum induction is at the center of the armature core. Diagrams. 1500 w. Zeitschr d Ver Deutscher Ing—Nov. 3, 1906. No. 80609 D.

Atoms.

New Conceptions of the Structure of Atoms (Neuere Vorstellungen über den Aufbau der Atome). Rob. Lang. Abstract of addresses at Stuttgart on atomic theories and the constitution of matter. 2500 w. Electrotech Zeitschr—Nov. 1, 1906. No. 80661 B.

Coercive Force.

The Value of the Coercive Force with Continuous and with Intermittent Magnetization (Ueber die Grösse der Koerzitivkraft bei Stetiger und bei Sprungweiser Magnetisierung). E. Gumlich. Showing that with soft iron the coercive force is greater when the magnetization changes gradually than when it changes *per saltum*.. Tables. 1500 w. Elektrotech Zeitschr—Oct. 25, 1906. No. 80655 B.

Dielectric Losses.

Dielectric Losses with High Pressure Alternate Currents. Dr. Paul Humann. Abstract translation. An account of experimental investigations, giving results. 1500 w. Elect'n, Lond—Nov. 16, 1906. No. 80722 A.

High Potentials.

Experiments with High Potentials. E. Jona. Reports experiments made with exceedingly high potentials on cables and aerial lines at the Milan Exhibition. Ills. 1300 w. Elect'n, Lond—Nov. 9, 1906. No. 80484 A.

Luminous Waves.

The Absorption of the Atmosphere for Light of Different Wave-Lengths. J. S. Dow. Discusses some suggestions made by C. Orme Bastian, in a paper before the Inst. of Elec. Engrs. 3000 w. Elec Rev, Lond—Nov. 2, 1906. No. 80352 A.

Rontgen Screen.

A Screen for Röntgen Rays which Retains the Image (Ein Röntgen-Schirm mit Deutlichen Nachbildern). Dr. Danneberg. Description of a screen coated with a modified form of zinc sulphide, which has many advantages for the direct observation of Röntgen ray images. 500 w. Elektrotech Zeitschr—Nov. 1, 1906. No. 80660 B.

Sodium Conductors.

The Use of Sodium as Conductor in Place of Copper. Anson G. Betts. Discusses the advantages and limitations of this material, reporting investigations made. Also editorial. 2700 w. Elec Wld—Nov. 10, 1906. No. 80375.

GENERATING STATIONS.

Brushes.

Carbon Brush Phenomena (Die Vorgänge an Kohlebürsten). Egon Siedek. Description of experiments and mathematical discussion supporting the view that changes in contact resistance of brushes may be explained on hypothesis that small arcs are formed between brush and commutator. Diagrams. 1600 w. Elektrotech Zeitschr—Nov. 15, 1906. No. 80665 B.

Practical Hints on Commutator Brushes (Praktisches über Kommutatorbürsten). G. Molnar. A discussion of various points. 3000 w. Elektrotech u Maschinenbau—Oct. 21, 1906. No. 80670 D.

Canton, O.

A Combined Heating and Lighting System at Canton, Ohio. R. W. Hutchinson, Jr. Illustrated description of the power house and central heating station, with explanation of details. 2000 w. Elec Rev, N Y—Nov. 10, 1906. No. 80380.

Coefficients.

Design Coefficients for Dynamo-Electric Machines. H. M. Hobart and A. G. Ellis. The present article considers the output coefficient of continuous current dynamo-electric machinery. 1000 w. Elec. Rev, Lond—Nov. 2, 1906. Serial. 1st part. No. 80351 A.

Constant Current.

Progress in the Construction of Direct Current Machines for Constant Current (Fortschritte im Bau von Gleichstrommaschinen für Konstanten Strom). Dr. E. Rosenberg. Well illustrated description of separately excited dynamo designed by the author, and adapted for arc lighting, train lighting, etc. Serial. 2 parts. 5000 w. Elektrotech Zeitschr—Nov. 15, 1906. No. 80662 each B.

Constant Direct-Current Dynamos. Dr. E. Rosenberg. Discusses the application and a few modifications of a machine invented by the author. It is well suited for train lighting, and delivers almost constant current under extreme conditions of service. 3000 w. Elec Wld—Nov. 10, 1906. No. 80377.

Finances.

The Revenues of Electric Stations in Medium and Small Sized Towns (Die Erträgnisse von Elektrizitätswerken in Mittleren und Kleinen Städten). G. Dettmar. A discussion of the finances and commercial end of electric stations in Germany, based on extensive statistics. Tables. Serial. 2 parts. 75000 w. Elektrotech Zeitschr—Oct. 18 and 25, 1906. No. 80652 each B.

How to Make a Small Electric Plant Pay. D. F. McGee. Describes the methods

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adopted to make an electrical property, operated in a town of 5,000 inhabitants, pay a dividend. 2300 w. Cent Sta—Nov., 1906. No. 80379.

Gas vs. Steam.

Suction Gas v. Steam. Compares two generating stations of similar size, and with units of the same size installed, showing an advantage in favor of steam. 1200 w. Elec Rev, Lond—Nov. 16, 1906. No. 80718 A.

Heyland Alternator.

Alternating Current Machine with Auxiliary Field for the Direct Compensation of Armature Reaction (Wechselstrom-Maschine mit Hilfsfeld zur Direkten Kompensierung der Ankerrückwirkung). A. Heyland. Illustrated description of method of making the armature reaction itself compensate its disturbing effects. 3500 w. Elektrotech Zeitschr—Nov. 1, 1906. No. 80657 B.

A Direct Method of Compensating the Armature Reaction of Alternators. A. Heyland. Explains a method based in principle on the provision of unequal air gaps for poles of opposite polarity in conjunction with a reduction of turns on the poles with the smaller air gap. Ills. 3500 w. Elect'n, Lond—Oct. 26, 1906. No. 80303 A.

New Method of Compounding Alternators. Alexander Heyland, in *Elektrische Bahnen und Betriebe.* Describes a method for automatically keeping the terminal voltage of an alternator constant at all loads. Ills. 1400 w. Elec Engr, Lond—Nov. 9, 1906. No. 80478 A.

Hydro Electric.

Winnipeg, Manitoba, 60,000-Volt Hydro-Electric Plant. V. D. Moody. Illustrated detailed description of a recently completed plant representing the most modern construction. 3500 w. Can Elec News—Nov., 1906. No. 80452.

Water Power Electrical Development in the Carolinas. J. C. Patton. An illustrated article giving information concerning developments for generating 150,000 electrical horse-power to cover a territory 150 miles in length, and 100 miles in width. 1200 w. Elec Wld—Nov. 10, 1906. No. 80378.

See also Civil Engineering, Water Supply.

N. Y. Central.

Port Morris Power Station of the New York Central Railroad. A. D. Williams, Jr. Illustrated description of a turbine station arranged on the unit system, with special hydraulic governing and complete facilities for handling coal and ash. 4800 w. Engr, U S A—Nov. 15, 1906. No. 80434 C.

Pole Construction.

A New Design for the Rotating Fields of Turbo-Dynamos (Eine Neue Polrad-Konstruktion für Wechselstrom-Turbodynamos). E. Rosenkötter. Illustrated description of method of securing rotating pole pieces of alternators, adopted by Bruce, Peebles & Co. of Edinburgh. 600 w. Elektrotech Zeitschr—Oct. 25, 1906. No. 80654 B.

Rutland, Vt.

Electric Railway Power at Rutland, Vermont. Illustrates and describes a new power development in the valley of East and Otter Creeks, and the country served. 2400 w. St Ry Jour—Nov. 24 1906. No. 80578.

Storage Battery.

The Polyphase-Storage Battery Plant at the Carlsfund Works in Gross Rhüden (Die Drehstrom-Pufferanlage der Gewerkschaft Carlsfund in Gross Rhüden). Max Henke. Illustrated description of plant with motor generators and buffer battery at a German electro-chemical works. 3000 w. Elektrotech Zeitschr—Nov. 8, 1906. No. 80664 B.

LIGHTING.

Illuminants.

Indoor Illuminants. James Swinburne. Paper read before the Assn. of Engrs.-in-Charge. Calls attention to points of importance in general and special lighting. 3000 w. Elec Engr, Lond—Nov. 16, 1906. Serial. 1st part. No. 80713 A.

Modern Electrical Illuminants. J. S. Dow. Discusses recent lamps introduced to improve the efficiency, considering the Nernst lamp, the mercury-vapor tube system, and others. 3000 w. Elec Engr, Lond—Oct. 26, 1906. No. 80301 A.

Illumination.

Data on Indoor Illumination. J. E. Woodwell. Abstract of a paper read before the Ill. Engng. Soc. Discusses the principles and factors and their application. Ills. 3300 w. Elec Rev, N Y—Nov. 3, 1906. No. 80254.

Location of Lamps and Illuminating Efficiency. Preston S. Millar. Abstract of a paper before the Ill. Engng. Soc. Considers the relative efficiency of four different methods of indoor illumination which are in common use to-day. 2000 w. Elec Rev, N Y—Nov. 17, 1906. No. 80430.

Incandescent Lamps.

Preliminary Measurements on Temperature and Selective Ratdiation of Incandescent Lamps. C. W. Waidner and G. K. Burgess. A communication from the Bureau of Standards reporting researches to determine the relative importance of temperature and of selective radiation in producing the very high efficiencies with filaments of carbon, tanta-

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lum, and tungsten. Also editorial. 1500 w. Elec Wld—Nov. 10, 1906. No. 80376.

The Determination of the Mean Horizontal Intensity of Incandescent Lamps by the Rotating Lamp Method. Eduard P. Hyde and F. E. Cady. Outlines four methods in use and gives the results of a valuable research on the effect of rotation upon the measurement of mean horizontal candle-power. 5000 w. Elec Wld—Nov. 17, 1906. No. 80432.

The William J. Hammer Collection of Incandescent Electric Lamps. Report of the Committee on Science and the Arts on the historical collection of incandescent electric lamps made and exhibited at the St. Louis Exposition of 1904, by Willis J. Hammer. Ills. 2500 w. Jour Fr Inst—Nov., 1906. No. 80405 D.

Mercury Vapor Lamps.

The Mercury Vapor Lamp in a Magnetic Field. Wilhelm Schenkel. Abstract translation. An investigation of the Hall effect in the mercury vapor lamp made to determine the nature of the luminous effect in the mercury arc. 1500 w. Elect'n, Lond—Nov. 9, 1906. No. 80485 A.

Photometer.

Investigation of a Weber Photometer (Einige Untersuchungen an einen Weberschen Photometer). Karl Satori. Experiments to determine constants, and discussion of operation. Curves. 700 w. Elektrotech Zeitschr—Oct. 28, 1906. No. 80671 D.

Street Lighting.

Notes on Street Lighting. J. I. Mange. Considers the electric arc, gas, and incandescent lamps, distribution and related matters. 2200 w. Munic Jour & Engr—Nov. 7, 1006. No. 80319 C.

Submarine.

Electric Arc Lamp for Submarine Work. Illustrated description. 600 w. Engr, Lond—Oct. 26, 1906. No. 80313 A.

A Submarine Lamp. Illustrated description of the Yale submarine lamp, invented by Francis G. Hall. 700 w. Sci Am Sup—Dec. 1, 1906. No. 80739.

MEASUREMENT.

Behrend Method.

Testing Alternating-Current Apparatus by the Behrend Method. Illustrations and information concerning this method devised by B. A. Behrend, for testing alternating-current generators and synchronous motors under full-load conditions while they are still in the shop. 500 w. Eng News—Nov. 15, 1906. No. 80447.

Galvanometers.

Factors Determining the Design of the D'Arsonval Galvanometer. L. A. Freudenberger. A mathematical analysis. 500 w. Elec Wld—Nov. 17, 1906. No. 80433.

Incandescent Lamps.

See Electrical Engineering, Lighting.

Oscillographs.

Oscillographs and Some of Their Recent Applications. David A. Ramsay. Describes the more recent developments of the Duddell oscillograph, and the problems it is well adapted to investigate. Ills. Also editorial. 2800 w. Elec Wld—Nov. 24, 1906. No. 80592.

Permeameter.

The Picou Permeameter. Albert Campbell. Illustrated description of the arrangement adopted by R. T. Picou in an instrument for the magnetic testing of iron, giving results of tests. 1500 w. Elect'n, Lond—Nov. 9, 1906. No. 80483 A.

Phase Differences.

Some Measurements on Phase Displacements in Resistances and Transformers. Charles V. Drysdale. Gives results of tests made by methods explained in an earlier article for the measurement of small differences of phase. 1800 w. Elect'n, Lond—Nov. 16, 1906. Serial. 1st part. No. 80719 A.

Resistances.

Some Notes on the Calculation of Star Resistances. Alfred Still. A study showing how to proportion the various resistances so as always to bring the shunt current into the required phase and that the most economical results will be obtained if the resistance in series with the pressure coil of the instrument be dispensed with, etc. Diagrams. 1800 w. Elec Engr, Lond—Nov. 9, 1906. No. 80477 A.

Secohmmeter.

The Use of the Secohmmeter for the Measurement of Combined Resistances and Capacities. S. R. Milner. Briefly describes this instrument and explains its use in the field named. 3800 w. Elect'n, Lond—Oct. 26, 1006. No. 80304 A.

Three-Phase.

The Measurement of Three-Phase Electrical Power and Energy. Prof. J. H. Dobson. Considers the magnitudes and phase relationships which exist between the currents which flow in each of the phases and in the distributing lines, and the electro-motive forces between the lines and each phase, discussing the actual measurements of power and energy. 3500 w. Jour S African Assn of Engrs—Sept., 1906. No. 80290 F.

Wattmeters.

The Standardizing Laboratory. H. B. Taylor. The present article discusses a testing circuit for alternating-current wattmeters, Ills. 2000 w. Elec Jour—Nov., 1906. No. 80285.

MOTORS.

Induction Motors.

Application of the Principal Types of Polyphase Induction Motors. W. Edgar Reed. Discusses the most important characteristics to be considered in making

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applications. 2200 w. Elec Jour—Nov., 1906. No. 80283.

Single-Phase.

The Starting of Single-Phase Commutator Motors. Rudolf Richter. Abstract translation from *Elektrotechnische Zeitschrift.* A report of tests, with diagrams. 1200 w. Elect'n, Lond—Nov. 16, 1906. No. 80721 A.

Standardization.

Standardization of Tramway Motors. A committee report presented at the Milan International Conference. 1800 w. Elec Engr, Lond—Nov. 2, 1906. No. 80350 A.

Synchronous Motors.

Troubles with Synchronous Motors. E. B. Raymond. Explains this motor as an alternating-current generator used to absorb current instead of giving it out. Discusses some of the troubles in operating, and means of correcting them. 1700 w. Engr, U S A—Nov. 15. 1906. No. 80437 C.

TRANSMISSION.

Iron Masts.

High Voltage Transmission Lines with Iron Masts (Ueber Hochspannungsleitungen mit Eisernen Masten). Ludwig Kallir. Discussion of long spans and iron towers or masts, and illustrated description of such lines now in use. Serial. 2 parts. 6500 w. Elektrotech u Maschinenbau—Oct. 21 and 28, 1906. No. 80669 each D.

High-Tension Overhead Lines on Iron Masts. From a paper by Herr L. Kallir, in *Elektrotechnik und Maschinenbau,* discussing the advantages of employing iron masts for the whole line in large long-distance transmission schemes. 1200 w. Elec Engr, Lond—Nov. 16, 1906. No. 80714 A.

Polyphase.

Polyphase Systems of Generation, Transmission and Distribution. M. A. Sammett. Considers the two-phase and three-phase systems, comparing their advantages and the two principal frequencies. 4000 w. Can Soc of Civ Engrs, Adv Proof—Nov. 15, 1906. No. 80547 D.

Strains.

Strains in Pole Lines. Aug. J. Bowie, Jr. Especially a study of the stresses due to the breakage of line wires, and the design of a pole line as an engineering structure. 2200 w. Elec Wld—Nov. 17, 1906. No. 80431.

MISCELLANY.

Domestic Appliances.

Electricity in the Home. H. W. Hillman. The writer lives in a thoroughly equipped electric house, and describes the devices and economy possible, and the advantages of domestic electric service. 2800 w. Cassier's Mag—Nov., 1906. No. 80209 B.

Electrical Exhibits and Demonstrations in Wanamaker's New York Store. Illustrated description of an interesting exhibit to demonstrate the operation and use of electrical devices for use in the home. 1500 w. Elec Wld—Nov. 3, 1906. No. 80257.

Factories.

Two Electrical Factories at Birmingham, England. Illustrated description of a factory for the manufacture of electric cooking and heating apparatus; and a factory for making conduits for electric wiring. 3000 w. Elec Rev, Lond—Nov. 9, 1906. No. 80481 A.

Lifting Magnets.

See Mechanical Engineering, Power and Transmission.

Review.

The Influence of Electrical Engineering (Ueber den Einfluss der Elektrotechnik). Prof. Karl Hochenegg. Inaugural address at the Vienna Technical College, giving a general review. 4000 w. Zeitschr d Oest Ing u Arch Ver—Nov. 2, 1906. No. 80623 D.

The Development of Electrical Engineering Since 1890 (Die Entwicklung der Elektrotechnik Seit 1890). Hr. Engelmann. Paper before the Aachen Section of the Verein, giving a general review. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 10 1906. No. 80619 D.

INDUSTRIAL ECONOMY

Accounting.

Cost Accounts. James Marwick. Considers some of the points which should be covered in a cost system and related matters. 1800 w. Eng Rec—Nov. 17, 1906. No. 80508.

Manufacturing Accounting and Cost keeping. John R. MacNeille. The first of a series of articles tracing through the various stages of production, the methods of accounting and the figuring of the cost of production. 5000 w. Business Wld—Nov. 15. 1906. Serial. 1st part. No. 80513.

Cost Accounting in the Brass Foundry. D. C. Eggleston. Outlines a system which has been gradually developed to meet the requirements of a large manufacturing works. 1200 w. Ir Age—Nov. 15, 1906. No. 80387.

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Metallurgical Accounts. Philip Henry Argall. Discusses the accountancy necessary for a smelter, its difficulties, and gives forms and statements proposed for use. 2500 w. Min & Sci Pr—Nov. 10, 1906. No. 80398.

Apprenticeship.

Modern Adaptations of the Apprenticeship System. O. M. Becker. A review of the difficulties in securing a sufficient number of trained mechanics, under modern shop methods, and of the systems adopted by a number of successful American employers for the training and education of new hands. 3000 w. Engineering Magazine—Dec., 1906. No. 80693 B.

The Apprenticeship System in America. Luther D. Burlingame. Discusses its relation to trade schools and the influence of each on American exports. 3000 w. Cassier's Mag—Nov., 1906. No. 80213 B.

A Plan to Provide for a Supply of Skilled Workmen. Magnus W. Alexander. Outlines the training given by the General Electric Co. at the Lynn Works, and gives suggestions to manufacturers for providing a constant supply of skilled workmen. 7500 w. Pro Am Soc of Mech Engrs (Sup)—Nov., 1906. No. 80549.

Canada.

Industrial Development of Canada. A review of recent rapid development and the conditions affecting industries. 4700 w. Am Mach—Vol. 29. No. 44. No. 80171.

Education.

Mining Education. Prof. J. A. Wilkinson. Discusses the training required, the preliminary education, college training, and post-graduate work. 6000 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1906. No. 80391 E.

Organization of the Society for the Promotion of Industrial Education. A report of the meeting for organization on Nov. 16, 1906, at Cooper Union, New York City. 2500 w. Am Mach—Vol. 29. No. 47. No. 80553.

The Engineering School of Cambridge University. Gives information concerning the University in general, and especially considers the engineering schools. 5000 w. Engng—Nov. 2, 1906. Serial. 1st part. No. 80356 A.

The Technical Schools of Germany (Les Ecoles Techniques Allemandes). André Pelletan. A review of students, courses and methods, with plans of laboratories, of the technical high schools of Germany, with some reference to technical education in other countries. 9000 w. Rev de Métallurgie—Nov., 1906. No. 80635 E+F.

Invention.

Profitable Mechanical Invention. Thaleon Blake. In the present article the change brought about by mechanical engineers who are professional inventors is discussed, and the mistakes of untrained inventors. 1800 w. Sci Am—Nov. 3, 1906. Serial. 1st part. No. 80186.

Management.

Modern Factory Management. Egbert P. Watson. Discusses some phases of shop administration, illustrating by examples the qualities of a successful manager, and considering the changes that have recently been introduced. 3500 w. Cassier's Mag—Dec., 1906. No. 80745 B.

Economy in Shop Management—Conditions Leading to Minimum Costs of Production. D. C. Eggleston. Suggestions for saving in prime costs. 1300 w. Am Mach—Nov. 15, 1906. No. 80389.

Mexico.

Mexico and Her Opportunities. Winthrope Scarritt. Describes this country and outlines its history, and gives information regarding its industries and opportunities for investment of capital. 4500 w. Cassier's Mag—Nov., 1906 No. 80207 B.

Panics.

Economic Crises, Their Causes and Prevention (Wirtschaftliche Krisen Ihre Ursachen und Ihre Verhütung). Dr. Flechtner. Discussion of the influence of excessive production, changes in the money metals, speculation and other causes of business depression, the effect of cartels or trusts in preventing panics, etc. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 20, 1906. No. 80602 D.

Patents.

Patents as a Factor in a Manufacturing Business. Edwin J. Prindle. A concluding paper of a very important series, dealing with the business law and ruling decisions as to patents for inventions made by employees. It shows how ownership would be decided or should be secured under all ordinary conditions. 4000 w. Engineering Magazine—Dec., 1906. No. 80699 B.

Transportation.

Transportation on Railways and Waterways (Die Transportverhältnisse auf Eisenbahnen und Wasserstrassen). Carl Schott. A general discussion of heavy freight transportation in America and Germany, particularly on German waterways. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 27, 1906. No. 80605 D.

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MARINE AND NAVAL ENGINEERING

Armored Cruiser.

The Russian Armored Cruiser "Rurik." Plan, dimensions and particulars of this recently launched vessel, describing the armament, propelling machinery, and pumping and draining arrangements. 3000 w. Engng—Nov. 16, 1906. No. 80725 A.

Battleships.

Speed in Battleships. An editorial review of the expressed views of Capt. A. F. Mahan, on the value of speed in a battleship, as given in a recent paper on the battle of the Sea of Japan. 5000 w. Engng—Nov. 16, 1906. No. 80728 A.

The British Battleship "Dreadnaught" (Le Cuirassé Anglais "Dreadnaught"). L. Piaud. Illustrated description. 4000 w. Génie Civil—Nov. 3, 1906. No. 80628 D.

Ferry Boat.

The FireProof Ferry Boat. F. L. Du Bosque. Read before the Soc. of Nav. Archts. & Marine Engrs. Considers some of the causes of fire in ferry-boats and the precautions taken, and gives an illustrated description of the Hammerton, which will be used between Camden and Philadelphia. 2000 w. Naut Gaz—Nov. 22, 1906. No. 80582.

Ice Breaking.

Ice Breaking Steamer for the St. Lawrence. Illustration, with brief description of the "Lady Grey," a vessel built for the Canadian Government. 700 w. Marine Rev—Nov. 15, 1906. No. 80427.

Lubrication.

See Mechanical Engineering, Steam Engineering.

Mauretania.

The 25¼-Knot Cunard Liner "Mauretania." Illustrated description of this new turbine vessel, and matters relating to its equipment. 1500 w. Sci Am—Nov. 3, 1906. No. 80185.

Propulsion.

Note on the Cavitation of Screw-Propellers. Sydney Walker Barnaby. Remarks on recent experiments and the methods of avoiding cavitation. Also gives tables and formulæ. 2000 w. Inst of Civ Engrs.—No. 3632. No. 80546 N.

On the Propulsive Power of Screws Necessary to Avoid Cavitation. Jacques Augustin Normand. Consideration of this subject, giving calculations to determine the necessary propulsive power of screws. 1200 w. Inst of Civ Engrs—No. 3600. No. 80538 N.

Rudder.

A Combined Double Rudder and Steering Gear. An illustrated description of this device, invented by E. Smethurst. 700 w. Engr, Lond—Oct. 26, 1906. No. 80312 A.

Safety at Sea.

Absolute Safety at Sea. Joseph R. Oldham. Describes a 1200-ft., 170,000 h. p. steamship which the writer believes will give absolute safety at sea, and he believes will be built within 25 years. 2500 w. Cassier's Mag—Nov., 1906. No. 80208 B.

Salving.

The Salving of the Guns of H. M. S. "Montagu." An illustrated account of very interesting work in connection with the saving of the ordnance of this stranded ship. 3000 w. Engng—Nov. 9, 1906. No. 80493 A.

Signals.

The Coston Night Signal. First Aid in Life Saving. Gives the history of this invention for marine use. Ills. 2000 w. Naut Gaz—Nov. 15, 1906. No. 80394.

Submarines.

The Catastrophe of the French Submarine Lutin. W. H. White. An account of the foundering of this vessel while practicing on the 17th of October, briefly describing the condition of the vessel when raised and placed in dry-dock. 1500 w. Engr, Lond—Nov. 9, 1906. No. 80502 A.

Turbines.

The Turbine Propelled Steamer Kaiser. Dr. Alfred Gradenwitz. Illustrated description of this express steamer of the Hamburg-American Line. 1200 w. Int Marine Engng—Dec.. 1906. No. 80561 C.

The First American-Built Turbine-Propelled Steamship. Describes the "Governor Cobb," giving many illustrations. 2500 w. Naut Gaz—Nov. 1, 1906. No. 80232.

Yacht.

Khedive's Turbine Yacht Mahroussa. An interesting illustrated account of this reconstructed vessel, now a three-screw turbine vessel of marked elegance. 1600 w. Engr, Lond—Nov. 16, 1006. No. 80731 A.

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AUTOMOBILES.

Aerocar.

A Description of the Model D Aerocar. A 2,000-pound car with a four-cylinder air-cooled motor rated at 20 h. p., carrying five passengers. 1400 w. Automobile—Nov. 15, 1906. No. 80402.

Ambulance.

A Scotch Automobile Ambulance. Brief description with illustrations. 400 w. Automobile—Nov. 15, 1906. No. 80401.

Bentall.

The Bentall Petrol Cars. An illustrated description of a new British car. 1200 w. Auto Jour—Nov. 17, 1906. Serial. 1st part. No. 80706 A.

Bodies.

Building of an Automobile Body. Illustrates and describes the process of construction of limousines at the Detroit factory. 600 w. Automobile—Nov. 1, 1906. No. 80198.

Chenard-Walcker.

The 16-20 H. P. Chenard-Walcker Car. Illustrates and describes the improvements to appear in the 1907 model. 1000 w. Autocar—Nov. 17, 1906. No. 80705 A.

Deasy.

The 24-H. P. Deasy Car. Illustrates and describes this all-British touring-car, and its novel features of construction. 2500 w. Auto Jour—Nov. 10, 1906. Serial. 1st part. No. 80464 A.

Electric Vehioles.

Electric Vehicles (Elektrische Kraftwagen). Dr. E. Sieg. Illustrated review of recent progress in electric automobiles and their use in cities. 2500 w. Elektrotech Zeitschr—Nov. 1, 1906. No. 80659 B.

History.

Ten Years Progress of the Motor Car Movement. Reviews the early history, and the development of the modern car from 1885 to the present day; giving the history of the automobile movements in the United Kingdom, and the sport of motor car racing. Ills. 38900 w. Motor Car Jour—Oct. 27, 1906. No. 80289 A.

Iris.

The "Iris" Six-Cylinder Motor Car. Describes a new type of these cars in which there have been introduced improvements of interest. Ills. 2000 w. Engng—Nov. 9, 1906. No. 80497 A.

Mercedes.

The 1907 Mercedes Cars. An illustrated detailed description of the 35-h. p. model. 2000 w. Auto Jour—Nov. 10, 1906. No. 80465 A.

Metallurgique.

The Metallurgique Petrol Car. Illustrates and describes the recent cars of this make, which have undergone considerable modification in construction. They are of the live-axle type. 1200 w. Auto Jour—Nov. 10, 1906. No. 80466 A.

The 60-80 H. P. Metallurgique Car. Illustrated detailed description of a new model built in Belgium. 600 w. Autocar—Nov. 3, 1906. No. 80343 A.

Napier.

The 1907 6-Cylinder Napier Cars. An illustrated article describing the improvements introduced in the latest cars of this firm. 1500 w. Auto Jour—Nov. 17, 1906. No. 80707 A.

New Engine Co.

The New Engine Company's Motor-Car. Illustrated description of an interesting new design exhibited at Olympia. Plate. 2400 w. Engng—Nov. 9, 1906. No. 80496 A.

The N. E. C. Petrol Carriage. An illustrated detailed description of a new British-built car, with engine beneath the body. 2700 w. Auto Jour—Nov. 3, 1906. Serial. 1st part. No. 80340 A.

New Models.

The 1907 Models. Illustrates and describes the 1907 Stearns, the Wayne, Logan model M, the Stoddard-Dayton, and the Dorris model B. 6000 w. Automobile—Nov. 22, 1906. No. 80569.

Omnibus.

Operating Costs of the Modern Auto-Bus. H. Vellguth. Abstract translation from the *Archiv jür Eisenbahnwesen.* Gives approximate costs of auto-bus service in Germany and England, explaining the conditions. 1200 w. St Ry Jour—Nov. 17, 1906. No. 80454 C.

The Edinburgh Motor Omnibus Service. Map and description of the Scottish Motor Traction Company's installation and its operation. Ills. 2500 w. Tram & Ry Wld—Nov. 1, 1906. No. 80488 B.

Pneumatic Hub.

The "Simplex" Pneumatic Hub. Remarks on the action of such hubs, with illustrated description of the constructional details. 2500 w. Auto Jour—Oct. 27, 1906. No. 80291 A.

Pullman.

The New York Company's 1907 Pullman Car. Illustrated description of the Model E touring car. 1200 w. Automobile—Nov. 1, 1906. No. 80100.

Radiators.

Concerning Radiators and Their Functions. M. Baudry de Saunier. An illustrated article discussing automobile water coolers, and radiators of various types. 1500 w. Automobile—Nov. 8, 1906. No. 80318.

We supply copies of these articles. See page 679.

Remodeling.

How to Improve an Old Car. Victor Lougheed. Suggestions for bringing an old car into the best possible working condition. 2000 w. Automobile—Nov. 8, 1906. Serial. 1st part. No. 80317.

Rim.

A New Removable Rim. Illustrated description of the rim invented by Dr. Doolittle of Toronto. 1200 w. Autocar—Nov. 17, 1906. No. 80704 A.

Siddeley.

The Siddeley 30-Horse-Power Motor-Car. Illustrated detailed description of a new design on exhibition at the Olympia Show. Plate. 2000 w. Engng—Nov. 9, 1906. No. 80495 A.

Side Slips.

The Debatable Problem of Side Slips. Thomas L. White. Begins a study of the cause and remedy. 1800 w. Automobile—Nov. 15, 1906. Serial. 1st part. No. 80399.

Singer.

The New Singer Cars. Describes and illustrates details of the 1907 model of this company. 1200 w. Autocar—Nov. 3, 1906. No. 80342 A.

Sunbeam.

The New Sunbeam Cars. Begins an illustrated detailed description of the new six-cylinder touring-car of this company. 1200 w. Autocar—Nov. 10, 1906. Serial. 1st part. No. 80469 A.

Thomas.

Details of the 1907 Thomas "Flyer." Illustrates and describes the changes introduced. 1400 w. Automobile—Nov. 15, 1906. No. 80400.

Thornycroft.

The 30-H. P. Thornycroft Car. Brief illustrated description of a new model—a four-cylinder 30-h. p. car. 900 w. Auto Jour—Nov. 17, 1906. No. 80708 A.

Town Carriages.

Town Carriage Competition. Gives awards and judges' report, with many illustrations of the cars. 3300 w. Auto Jour—Nov. 3, 1906. No. 80341 A.

Training.

Training the Novice to Drive. Illustration, with brief description of the device adopted at the Victoria Street Motor Garage, London. 600 w. Auto Jour—Nov. 10, 1906. No. 80467 A.

Vauxhall.

The 12-16 H. P. Vauxhall Car. The present number describes the engine of this new car. 900 w. Autocar—Nov. 10, 1906. Serial. 1st part. No. 80468 A.

Weigel.

The 40 H. P. Weigel Gear-Driven Car. Illustrates and describes details of this car. 2000 w. Autocar—Oct. 27, 1906. No. 80292 A.

White.

Steam Plant of the White Motor Car. R. C. Carpenter. An illustrated description of this plant and the results of a series of tests, as an example of what can be accomplished in the use of steam of high pressure and with a high degree of superheat. 6800 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80523 C.

The 1907 White Steam Cars. Remarks on the stages of progress in these cars, with illustrated description of two new models and a radical modification of system. 2800 w. Auto Jour—Nov. 17, 1906. No. 80709 A.

COMBUSTION MOTORS.

Alcohol.

Alcohol as a Motor Fuel. A. J. McKinney. Briefly considers the advantages and claims as a fuel. 1700 w. Autocar—Oct. 27, 1906. No. 80294 A.

Gas Engines.

Coal Gas for Motive Power and Heating. Dugald Clerk. Advocates the gas engine, driven by town gas, giving information in regard to its efficiency and cost of operation as compared with various fuels. 4000 w. Gas Wld—Nov. 10, 1906. No. 80463 A.

Experiments to Determine the Conditions in a Gas Engine Cylinder. Abstract of a paper by Dugald Clerk, on the phenomena of the working fluid in the cylinder of the internal-combustion engine. Presented to the Royal Society. 2500 w. Eng Rec—Nov 17, 1906. No. 80505.

Large Gas Engines. H. A. Humphrey. Second lecture at Olympia. Considers types and some of their characteristics. 3500 w. Jour Gas Lgt—Oct. 23, 1906. No. 80288 A.

Progress and Experience in the Construction of Large Gas-Engines. H. Bonte. (Abstract.) Deals with structural details, the operation, the relation between the power and dimensions, their application, etc. Ills. 4000 w. Engng—Nov. 2, 1906. No. 80360 A.

Gasoline Motors.

Light-Weight Gasoline Motors for Aeronautical Work. Illustrated description of the new Levavasseur motor. 1500 w. Sci Am Sup—Nov. 24, 1906. No. 80594.

Ignition.

Electrical Ignition in Internal Combustion Engines. F. W. Springer. A review of the writer's investigations to determine the most advantageous features to be embodied in the construction of apparatus for this purpose. 2500 w. Elec Wld—Nov. 24, 1906. Serial. 1st part. No. 80590.

Petroleum Engine.

The Koerting 200-Horse-Power Valveless Two-Cycle Petroleum Engine for Submarine Boats. Describes this interesting internal-combustion motor, illustrating the testing-shop, and details of the

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engine. 1000 w. Sci Am Sup—Nov. 10, 1906. No. 80275.

HEATING AND COOLING.

Ancient Methods.

Ancient Heating Methods. Charles F. Hauss. Illustrates and describes the charcoal pans or braziers used, discussing the effect of the products of combustion and their efficiency. 2500 w. Met Work—Nov. 24, 1906. No. 80568.

Cooling.

Heat-Dissipation with Especial Reference to the Annealing of Plate Glass. Discusses some of the problems having a direct bearing on the annealing of glass sheets. Ills. 12700 w. Pro Engrs' Soc of W Penn—Nov., 1906. No. 80531 D.

Electric Heating.

The Prometheus System of Electric Heating. This system consists primarily of resistances composed of metallic films deposited on insulating bases, the metallic film being protected by enclosure in a metallic case, from which it is insulated. Ills. 1500 w. Mech Engr—Oct. 27, 1906. No. 80299 A.

Fan Blowers.

The Realm of the Fan Blower. Walter B. Snow. Illustrates and describes some of the many applications made of fan blowers. 2000 w. Cassier's Mag—Nov., 1906. No. 80212 B.

Furnace Heating.

Highest Economy in Furnace Heating. Considers the proper temperatures, ventilation and coal consumption for different outside temperatures. 2000 w. Met Work—Nov. 10, 1906. No. 80264.

Garages.

Heating Motor Houses. Considers the methods and difficulties, suggesting apparatus. 2000 w. Autocar—Oct. 27, 1906. No. 80293 A.

Hot-Water.

A Rapid Current Hot Water Heating System. Illustrates and describes a system used recently in Germany and England, known as the Brückner system. The rapid circulation of the water is produced by a short length of pipe in which steam separation and emulsion take place. 1000 w. Eng News—Nov. 22, 1906. No. 80555.

Indirect Heating.

Indirect Gravity Heating. E. T. Child. Gives simple and reliable methods for determining the amount of radiating surface and the flue and register sizes for varying heights. Also editorial. 1600 w. Met Work—Nov. 3, 1906. No. 80206.

Low Temperatures.

Low Pressures: The Death of Matter. Georges Claude. Translated from *L'Air Liquide*, by B. F. Isherwood. Discusses the change of views brought about by the search for the absolute zero. 3000 w. Jour Fr Inst—Nov., 1906. No. 80408 D.

Refrigeration.

Closing Down a Plant. J. C. Calhoun. Valuable suggestions in regard to what to do when closing down an ice making or refrigerating plant prior to overhauling or repairing. 2200 w. Ice & Refrig—Nov., 1906. Serial. 1st part. No. 80223 C.

Overhauling the Ice Plant. E. T. Skinkle. Suggestions on overhauling an ice plant when shut down at close of season. 3300 w. Ice & Refrig—Nov., 1906. No. 80224 C.

Planning an Absorption Ice Plant William S. Luckenbach. Gives details of arrangement of machinery and piping in a plant operated on this system. 2000 w. Engr, U S A—Nov. 15, 1906. No. 80435 C.

The Application of Mechanical Refrigeration to Ice Cream Manufacture. Jos. H. Hart. Briefly describes the change in methods made necessary by the great quantities of ice cream required for large cities, describing a refrigerating plant for ice cream making, and the manufacture of this product. 2500 w. Jour Fr Inst—Nov., 1906. No. 80409 D.

Ventilation.

A Heterodox View of Ventilation. Aims to show wherein the downdraft system is wrong and to explain a rational system of ventilation. Ills. 2000 w. Can Engr—Nov., 1906. No. 80272.

HYDRAULICS.

Fluid Apparatus.

Remarks on Some Fluid Apparatus. John Richards. A lecture delivered at the University of California. On the force of waves, centrifugal pumps, etc. 2000 w. Cal Jour of Tech—Nov., 1906. No. 80411.

Pumping Plants.

A Comparison of the First Cost and Cost of Operation of Pumping Plants Driven by Steam and Oil Engines. Francis Head. Gives a comparison of the prices submitted to the City of Philadelphia for bids on low-lift pumping machinery for the Torresdale filters. Ills. 1300 w. Pro Engrs' Club of Phila—Oct., 1906. No. 80234 D.

Pumping Plant at Portsmouth Dockyard. Illustrates and describes a salt-water pumping-plant introduced to supply the fire services, and also water for other purposes for which sea-water is as suitable as fresh. 700 w. Plate. Engng—Nov. 2, 1906. No. 80359 A.

Foundations for Pumping Engines. Charles A. Hague. Discusses a number of cases and the conditions to be met, and the methods of successfully preparing the foundations for the engines. 5600 w. Cassier's Mag—Nov., 1906. No. 80211 B.

Rotary Pump.

Test of a Rotary Pump. W. B. Gregory. Describes the plant tested, the property of the Abbeville, La., Canal Company, used

to furnish water for rice irrigation; also the tests made, giving results. Ills. 3000 w. Pro Am Soc of Mech Engrs (Sup)—Nov., 1906. No. 80550.

Suction Pipes.

Suction Pipes. H. Aughtie. How to determine the limiting height of the suction pipe of a pump. 800 w. Mech Engr—Nov. 10, 1906. No. 80476 A.

MACHINE WORKS & FOUNDRIES.

Casting Plant.

A Modern Car Wheel Casting Plant. Illustrated detailed description of the straight floor system employed in the C., M. & St. P. R. Co.'s new foundry at West Milwaukee, Wis. 3500 w. Ir Age—Nov. 8, 1906. No. 80265.

Castings.

Making Brass Castings on End in Snap Flasks. J. A. Smith. Illustrates and describes the method used by the writer with success. 500 w. Brass Wld—Nov., 1906. No. 80514.

Result of Pouring Manganese-Bronze in a Pasty Condition. Erwin S. Sperry. An explanation of the treatment this material requires to obtain satisfactory results. Ills. 600 w. Brass Wld—Nov., 1906. No. 80516.

See also Railway Engineering, Motive Power and Equipment.

Cores.

Core Making. E. L. Rhead. An illustrated article considering principally the making of dry-sand cores, and machines for straight cores. 4000 w. Mech Engr—Nov. 3, 1906. No. 80346 A.

Facing Machine.

Napier's Barbette Facing Machine. Illustrations, with brief description, of a powerful machine for facing the gun-roller paths and surface for circular racks, as well as the upper faces of the barbettes of warships. 400 w. Engng—Oct. 26, 1906. No. 80307 A.

Foundry.

A Light Gray Iron Specialty Fountry. Illustrated detailed description of a plant in Cleveland, O. 2000 w. Foundry—Nov., 1906. No. 80158.

Foundry Department of the Lunkenheimer Company, Cincinnati, O. Illustrated detailed description. 1700 w. Foundry—Nov., 1906. No. 80159.

Foundry Costs.

How Can Foundry Costs be Reduced (Wie Können die Produktionskosten einer Giesserei Herabgezogen Werden)? E. Freytag. Discussion of foundry economy and management. Tables. 2000 w. Stahl u Eisen—Nov. 1, 1906. No. 80677 D.

Furnaces.

Fisher's Improvement in Metal Furnaces. Illustrated description of an improved melting furnace which is considered quite a departure from common practice. 2000 w. Ind Wld—Nov. 3, 1906. No. 80221.

Grinding.

A Machine for Grinding Concave Friction Disks. H. F. Noyes. Illustrated description of a new application for the grinding machine, designed to grind the friction disks used to obtain speed variation in the reversal mechanism of the Landis grinding machine. 800 w. Am Mach—Vol. 29. No. 47. No. 80552.

Jigs.

Drill Jigs. E. R. Markham. States the requirements of such tools, and considers their design and manufacture. 2000 w. Mach, N Y—Nov., 1906. Serial: 1st part. No. 80169 C.

Special Tools for Drilling Holes in Mine and Percussion Fuses and Firing Rings. W. R. Bowers. Illustrates and describes some special jigs for this work. 1200 w. Mach, N Y—Nov., 1906. No. 80168 C.

Lubricators.

The Construction of Force Feed Lubricators. Begins a description of types of force feed lubricators, with illustrations showing the mechanism. 1100 w. Automobile—Nov. 1, 1906. Serial. 1st part. No. 80197.

Melting.

Some Hints on Melting Metals and Alloys. Walter J. May. Suggestions for securing the least cost in fuel, loss of metal, and least cost in crucibles. 2000 w. Prac Engr—Nov. 2, 1906. No. 80344 A.

Mixtures.

Foundry Mixtures. Dr. Bradley Stoughton. Read before the Pittsburgh Found. Assn. An illustrated article discussing the effects of various impurities on pig iron. 3500 w. Ir Age—Nov. 15, 1906. No. 80386.

Patterns.

A Piston Valve Cylinder Pattern. H. J. McCaslin. Illustrates and describes the construction of the pattern, the core box, and the molding. 2000 w. Foundry—Nov., 1906. No. 80160.

Making Foundry Patterns. Walter J. May. in *English Mech. & Wld. of Science*. An illustrated article discussing the making of patterns. 3000 w. Sci Am Sup—Nov. 3, 1906. No. 80188.

Notes on Metal Patterns. H. N. Tuttle. Remarks confined to patterns known as cards or gates. 2000 w. Foundry—Nov., 1906. No. 80161.

Perforating.

A New Perforating Machine. Illustrates and describes a machine adjustable to any length of sheet. 2700 w. Am Mach—Vol. 29. No. 44. No. 80172.

Planers.

Shifting-Belt Planer Drive. E. H. Waring. Comments on an article by W. H. Henley, with suggestions. 1600 w. Am Mach—Vol. 29, No. 45. No. 80280.

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Printing Machine.

A New Steel-Plate Printing and Embossing Machine. A. Frederick Collins. A machine that inks, stamps, and delivers as many impressions in an hour as the most skilled hand stamper can turn out in a day is illustrated and described. 1000 w. Sci Am—Nov. 10, 1906. No. 80274.

Repetition Work.

The Need for Increasing the Attractiveness of Repetition Work. W. O. Horsnaill. Considers the main factors that tend toward the discouragement of ambition among the younger workmen, and the methods adopted to meet the difficulty. 1500 w. Prac Engr—Nov. 16, 1906. No. 80710 A.

Riveter.

A New Horizontal Boiler Riveter Installation. Illustrates and describes this apparatus which will rivet a boiler 6 feet in diameter, with plates up to 10 feet 6 inches in length. 500 w. Eng News—Nov. 8, 1906. No. 80331.

Shops.

Modern Machine Shop Requirements. Joseph Horner. Illustrates and describes the aids to rapid and economical output introduced and the changes in methods. 2500 w. Cassier's Mag—Dec., 1906. Serial. 1st part. No. 80750 B.

See also Civil Engineering, Construction; Electrical Engineering, Miscellany; Railway Engineering, Permanent Way and Buildings.

Steel Cutting.

The Cutting of Steel by the Combustion Process. S. D. V. Burr. Describes a process perfected by Felix Jottrand, a Belgian engineer, which is reported both rapid and economical and capable of wide application. 900 w. Ir Age—Nov. 1, 1906. No. 80155.

Threading.

Pipe Cutting and Threading Machine. Illustrates and describes a new machine for this work. 1000 w. Ir Trd Rev—Nov. 1, 1906. No. 80164.

Tool Construction.

Some Devices Used in Machine Tool Construction. Thomas R. Shaw. Presents details of interest, including an adaptation of the dropping worm box, with automatic knock-off motion, a novel quick-acting centre for supporting mandrel, a dividing arrangement, etc. Ills. 2000 w. Mech Engr—Nov. 3, 1906. No. 80347 A.

MATERIALS OF CONSTRUCTION

Abrasives.

Alundum, the New Abrasive. An account of a valuable material for grinding-wheels, nearly as hard as diamond, made by the power of Niagara Falls. 1500 w. Am Mach—Vol. 29. No. 45. No. 80281.

Alloys.

Bearing Alloys. Alfred Suggate. Read to the Manchester Students, Inst. of Civ. Engrs. Describes some of the conditions necessary to make a selected alloy a success. Deals principally with white metal. 2800 w. Engr, Lond—Oct. 26, 1906. Serial. 1st part. No. 80311 A.

Bolts.

Working Strength of Bolts. F. E. Cardulls. Discusses the stresses due to screwing up bolts to make them steam tight. Ills. 2700 w. Mach, N Y—Nov., 1906. No. 80166 C.

Brass Wire.

The Manufacture of Brass Wire. E. J. Bolton. Brief discussion of the important operations in the manufacture. 2500 w. Ir & Coal Trds Rev—Oct. 26, 1906. No. 80315 A.

Rubber.

The Mechanical Examination and Analysis of Manufactured Rubber. Reviews two recent papers, one by Pierre Breuil, the other by Em. Camerman, containing interesting information regarding the mechanical properties of manufactured rubber and its analysis. Gives a summary of the results obtained by different experimenters. 2000 w. Eng News—Nov. 22, 1906. No. 80559.

Solders.

Solders. Translated from Edmund Schlosser's "Das Löten und die Bearbeitung der Metalle." A classification and discussion of these mixtures and their manufacture and uses. 3000 w. Sci Am Sup—Nov. 10, 1906. Serial. 1st part. No. 80276.

Steels.

Special Steels for Motor-Car Construction. Briefly considers nickel, chrome, silicon, tungsten, vanadium, and chrome-nickel steels. 3000 w. Ir & Coal Trds Rev—Oct. 26, 1906. No. 80314 A.

The Influence of Nickel and Carbon on Iron. G. B. Waterhouse. A research considering a series of steels of constant nickel with varying carbon percentages. 1200 w. Elec-Chem & Met Ind—Nov., 1906. Serial. 1st part. No. 80426 C.

Brittleness in Steel. C. E. Stromeyer. From the annual report for 1905 to the Manchester Steam Users' Assn. Observations made in English boiler plate practice. 2700 w. Ir Age—Nov. 22, 1906. No. 80512.

Tool Steel.

The Manufacture of Tool Steel. E. T. Clarage. Address before the N.-W. Ry Club, giving facts of interest in regard to this industry. 3000 w. Am Mach—Vol 29. No. 44. No. 80174.

The Development of High-Speed Steel in Germany (Die Entwicklung des Schnellarbeitstahles in Deutschland). O. Thallner. History, chemical analyses, description of processes of manufacture, micrographs, practical experience. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 20, 1906. No. 80600 D.

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Waste.

Utilization of Waste Materials. Dr. Theodor Koller. The present article considers wood waste, and horn shavings. 5500 w. Sci Am Sup—Nov. 10, 1906. Serial. 1st part. No. 80279.

MEASUREMENT.

Dynamometer.

Improved Transmission Dynamometer. W. F. Durand. Illustrated description. 1000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80529.

Extension Heat.

The Heating of Metals in Tension Tests (Die Wärmevorgänge Beim Längen von Metallen). Dr. H. Hort. Illustrated description of experiments on bars of iron, of copper and of steel, to determine the heating effects above the elastic limit. 2500 w. Zeitschr d Ver Deutscher Ing—Nov. 10, 1906. No. 80618 D.

Flow.

The Flow of Fluids in a Venturi Tube. Edgar Park Coleman. Describes tests showing that the Venturi tube is an instrument of convenience and precision when used for measuring the quantity of air or gas (and in some cases of steam) flowing through it. Ills. 2000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80527.

Friction.

Testing Machine for Oils, Bearings, and Journals; Cooper's Hill College. Illustrated description of a machine designed on new lines, by James Hopps, for testing oils, as well as the friction of journals and bearings of different alloys. 1200 w. Engng—Nov. 2, 1906. No. 80358 A.

International Congress.

The Fourth Congress of the International Association for the Testing of Materials, at Brussels, September, 1906 (IV. Congrès de l'Association Internationale pour l'Essai des Matériaux de Construction, Bruxelles, Septembre, 1906). Illustrated account of exhibits and subjects discussed. Serial. 1st part. 3000 w. Génie Civil—Nov. 3, 1906. No. 80629 D.

Metric System.

Our Present Weights and Measures and the Metric System. Henry R. Towne. An argument for a Technical Commission to study and report upon the whole question of weights and measures. 12800 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80525 C.

Mouthpieces.

The Strength of a Mouthpiece Ring and Cover. Gives the calculations made for figuring the strength of a cover and mouthpiece ring, calling attention to points in the designing of such vessels. Ills. 2200 w. Mach, N Y—Nov., 1906. No. 80167 C.

Nozzles.

Flow of Air in Nozzles. Frank Foster. An investigation, especially of the conditions in ordinary gas-turbine work. 1500 w. Mech Engr—Oct. 27, 1906. Serial. 1st part. No. 80297 A.

Slide Rules.

Notes on Slide Rules (Note Relative aux Abaques à Alignement). Dr. G. Dumas. Discussion of slide rules for various purposes, and of their theory. Diagrams. Serial. 2 parts. 5500 w. Bull Tech d la Suisse Romande—Oct. 25, Nov. 10, 1906. No. 80642 each B.

Spring Calculations.

Dr. Proell's Graphical Table for the Calculation of Helical Springs (Abaque pour le Calcul des Dimensions des Ressorts Hélicoidaux Cylindriques Etabli par Dr. R. Proell). Fritz Krull. Mathematical discussion of the determination of curves and tables. Diagram. 1200 w. Rev de Mécanique—Oct. 31, 1906. No. 80637 E + F.

Testing Engineer.

The Testing Engineer. Chas. P. Dudley. Address (slightly condensed) delivered before the Am. Soc. for Test. Mat. Remarks on the work of the testing engineer and the preparation needed. 4000 w. Elec Jour—Nov., 1906. No. 80284.

Torsion Meter.

A New Torsion Meter for Measuring the Power of Marine Steam Turbines. Frank C. Perkins. Illustrated description of an instrument and method for measuring the power of steam turbines when applied to ship propulsion. 1000 w. Int Marine Engng—Dec., 1906. No. 80562 C.

Vibration.

Instruments for Measuring the Secondary Movements of Vehicles in Motion. M. Sabouret. Translated from the French. Describes apparatus for recording secondary movements, combined secondary movements, and divided secondary movements. Diagrams. 1000 w. Eng News—Nov. 15, 1906. No. 80445.

POWER AND TRANSMISSION.

Blast Furnaces.

Modern Charging Apparatus for Blast Furnaces (Moderne Hochofen-Begichtungs-anlagen). Illustrated description of inclined elevators for raising the material to the top of furnace, built by the Benrath Machine Works. 2000 w. Stahl u Eisen—Nov. 1, 1906. No. 80675 D.

Blowing Engine.

A New Blowing Engine for Steel Works (Neue Stahlwerks-Gebläsemaschine). Oskar Simmersbach. Illustrated description of compound steam blowing engine, with indicator diagrams. 1 plate. 400 w. Stahl u Eisen—Nov. 1, 1906. No. 80676 D.

Cableway.

A Bleichert Cableway in the Mountains of Northern Argentina (Die Erschliessung der Nordargentinischen Kordilleren Mittels einer Bleichertschen Drahtseil-

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bahn für Güter und Personen). G. Dieterich. A very complete illustrated description of an aerial tramway for passengers and freight, from Chilecito to the Famatina copper mines, 21.5 miles long, overcoming a difference of elevation of 11,500 feet. Serial. 1st part. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 3, 1906. No. 80607 D.

Wire Rope Tramway Engineering. S. S. Webber. An illustrated article considering this means of transporting and the conveyors and appliances used. 3800 w. Cassier's Mag—Dec., 1906. No. 80749 B.

Centrifugal Machinery.

The Efficiency of Centrifugal Ventilators and Pumps (Die Wirkungsgrade von Ventilatoren und Zentrifugalpumpen). L. Schütt. Theoretical discussion, with confirmatory experiments on centrifugal ventilating fans. Formulæ, curves and tables. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 20, 1906. No. 80603 D.

Coal Mines.

Some Notes on the Mechanical Equipment of Collieries. E. M. Hann. Read before the Inst. of Mech. Engrs. Describes the equipment at the Bargoed Colliery. Electricity is extensively used. 4000 w. Mech Engr—Nov. 10, 1906. No. 80475 A.

Compressed Air.

A High Duty Air Compressor. O. P. Hood. Reports the results found in a test of a high duty air compressor installed at the Champion copper mine at Painesdale, Mich. Ills. 3000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80521 C.

Measuring the Efficiency of Turbine Air-Compressors. Discusses a point raised in a letter from Mr. Frank Foster, as to how far it is legitimate to deduce the hydraulic efficiency from the degree by which the final temperature exceeds that due to adiabatic compression. 1000 w. Engng—Nov. 16, 1906. No. 80727 A.

Compressed Air Curves and Tables. L. L. Willard. Gives formulæ for calculating the horse-power required to compress a given volume of free air to a given pressure and curves plotted from values found, with tables. 800 w. Compressed Air—Nov., 1906. No. 80390.

Some Recent Advances in the Application of Compressed Air. W. L. Saunders. Remarks on methods for securing economy in the use of compressed air, and the advantages that have followed. 2200 w. Cassier's Mag—Dec., 1906. No. 80747 B.

Cranes.

150-Ton Derricking Crane at the Imperial German Naval Base, Kiautschau, China. Illustrated description of an interesting type of fixed hammer derricking crane, electrically operated. 1500 w. Prac Engr—Nov. 2, 1906. No. 80345 A.

Crank Mechanism.

The Determination of the Revolving Masses in Crank Mechanisms (Die Ermittlung der Schwungmassen im Schubkurbelgetriebe). Richard v. Mises. A mathematical discussion of crank and flywheel problems in reciprocating engines. Serial. 3 parts. 6500 w. Zeitschr d Oest Ing u Arch Ver—Oct. 19, 26, Nov. 2, 1906. No. 80620 D.

Department Store.

Engineering Features of the New Altman Department Store Building, New York. Brief description of the features which furnish power for elevators, lighting, bells, and all requirements of this large modern dry-goods business. 1600 w. Elec Wld—Nov. 3, 1906. No. 80256.

Electric Driving.

Electrical Equipment of the Bath Portland Cement Company, Bath, Pa. Illustrated description of the applications of induction motors in this plant. 2200 w. Elec Rev, N Y—Nov. 17, 1906. No. 80429.

Electric Motor Drive. George H. Schaeffer. A short comparison between belt-driven and motor-driven machinery, giving the advantages of the latter. 1000 w. Am Mach—Vol. 29. No. 44. No. 80173.

Elevator Accidents.

The Prevention of Elevator Accidents. Reginald Pelham Bolton. Deductions from a large group of accidents recently studied by the author as an expert, pointing out the specific causes and indicated preventives. Also discusses the present very unsatisfactory position of the accident companies and inspectors, and suggest a system of insurance which should really insure. 2500 w. Engineering Magazine—Dec., 1906. No. 80698 B.

Elevators.

Tests of a Plunger Elevator Plant. Arthur J. Herschmann. Gives tables referring to the commercial tests made on the plunger elevator plant of the Trinity Building, New York City, while in regular operation. Ills. 1200 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80528.

Friction Clamp.

Apparatus for Clamping by Means of Friction (Rapport Sur des Appareils de Calage par Frottement). E. Sauvage. Illustrated description of various clutch and brake mechanisms designed by M. Rémondy, utilizing the friction of a wire wound around a cylinder. 1500 w. Bull Soc d'Encour—Aug., Sept., Oct., 1906. No. 80634 G.

Gas Power.

The Evolution of Gas Power. F. E. Junge. A review of the history of de-

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velopment of internal combustion engines, discussing types and improvements in design and construction, methods of regulation, etc., fuels used and other problems. 10000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80519 C.

Producer Gas Power Plant. J. R. Bibbins. An inquiry into the operation, efficiency, and construction of a typical modern industrial plant—the plant serving the entire Gould manufacturing properties at Depew, N. Y. Ills. 4000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80520 C.

Hoists.

Colliery Hoists. F. Ernest Brackett. Gives results of an investigation made of the design and efficiency of winding engines. 3300 w. Eng & Min Jour—Nov. 3, 1906. No. 80252.

Magnets.

Lifting Magnets. Arthur C. Eastwood. An illustrated review of the development of lifting magnets, and matters relating to their use. 3000 w. Cassier's Mag—Dec., 1906. No. 80744 B.

Mill Power.

Electrical v. Mechanical Power in Mills. Abstract of a paper by A. Sterling. Considers briefly the main methods of distributing power in factories, their efficiency and cost. 1000 w. Elec Engr, Lond—Nov. 9, 1906. No. 80479 A.

Ore Unloaders.

Hulett Ore Unloaders at Buffalo. Brief illustrated description of the latest installation of these machines, located on the docks of the Pennsylvania railroad. 500 w. Ir Trd Rev—Nov. 15, 1906. No. 80396.

Power Plant.

The Planning and Construction of the Power Plant. A. E. Dixon. The fourth number of this series is devoted to the water supply of the plant and its heating and purification. 4500 w. Engineering Magazine—Dec., 1906. No. 80696 B.

Rope Transmission.

Power in Rubber Manufacture. Illustrates and describes a novel application of rope transmission in a Detroit plant. Describes the work carried out, and the equipment. 3300 w. Engr, U S A—Nov. 1, 1906. No. 80200 C.

STEAM ENGINEERING.

Balanced Draft.

The Balanced Draft Gas Producer Furnace as Applied to Steam Boilers. Embury M'Lean. Read before the Brooklyn Engrs. Club. Illustrates and describes this apparatus for producing perfect combustion of fuel under boilers in any furnace. 1200 w. Boiler Maker—Nov., 1906. Serial. 1st part. No. 80388.

Blowoff Tank.

Concerning Blowoff Tanks. Explains the necessity for such tanks in cities, and illustrates and describes a correct form of construction. 2000 w. Locomotive—Oct., 1906. No. 80220.

Boilers.

Boiler and Setting. A. Bement. Illustrates and describes an improved design for use with bituminous coal—the tile roof furnace, said to secure smokeless combustion. 1200 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80522.

Some Notes on Boiler Defects and Failures. W. H. Fowler. Notes on patches and patching, lap fractures, screwed stud stays, etc. Ills. 1800 w. Mech Engr—Nov. 3, 1906. No. 80348 A.

Boiler Room.

Boiler Room Economy. Eugene L. Griggs. Suggestions concerning the use of cheap fuel, good firing and various other points that tend to reduce the coal bill. 1000 w. Elec Wld—Nov. 2, 1906. No. 80258.

Boiler Tubes.

The Deformation of Fire Tubes of Boilers Under External Pressure (Die Abweichung von der Kreisrunden Form bei Flammrohren mit Aeusserem Druck). O. Knaudt. An illustrated description of the deformation and failure of round corrugated boiler tubes. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 3, 1906. No. 80608 D.

British Engines.

Small British Steam Engines. W. H. Booth. Illustrates and describes interesting designs. 3000 w. Cassier's Mag—Dec., 1906. No. 80746 B.

Clearance.

Clearance and Receiver Drop in the Design of Compound Engines. P. F. Walker. Outlines a rational method of dealing directly with the quantities mentioned. 2300 w. Int Marine Engng—Dec., 1906. No. 80560 C.

Cut-off.

Effects of Alterations to the Cut-Off in the Cylinders of Triple-Expansion and Compound Engines. W. S. Williams. An explanation. 5000 w. Prac Engr—Oct. 26, 1906. No. 80295 A.

Draft Gauge.

Kent's Draught Gauge. Diagram, with description and explanation of its use in measuring the draught of chimneys. 1000 w. Mech Engr—Oct. 27, 1906. No. 80298 A.

Firing.

The Firing of Steam Boilers. F. Smal and L. Timmermans, in the *Revue Univ. des Mines*. An interesting account of the trials and results of a competition at the Liége Exhibition, and discussion of the influence of efficient stoking on costs. 2000 w. Col Guard—Nov. 9, 1906. Serial. 1st part. No. 80491 A.

Fuels.

Fuel Economy in Boiler Furnaces at Cripple Creek. J. Elmer Parkison. Illus-

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trated description of a lignite burner recently introduced. It embodies the application of the gas-producer principle to boiler practice. 800 w. Min Rept—Nov. 22, 1906. No. 80596.

The Burning of Washer Slate and Coke Braize. C. G. Atwater. Gives a report of trials made with this low-grade fuel at a boiler plant at Sydnev, Cape Breton. A daily consumption of 63 tons showed a saving of over $43 a day over coal. 2500 w. Eng Rec—Nov. 24, 1906. No. 80577.

Gas Analysis.

Gas Analysis for Steam-Users. John B. C. Kershaw. The present number discusses the characteristics of the waste gases, and taking samples. 3500 w. Elect'n, Lond—Nov. 16. 1906. Serial. 1st part. No. 80720 A.

Injectors.

Automatic and Positive Injectors. Frank O'Leary. Explains how a lifting injector may be adapted to non-lifting conditions and vice versa. 1000 w. Engr, U S A—Nov. 1, 1906. No. 80201 C.

Lubrication.

Lubricating Arrangements for Marine Engines (Schmiervorrichtungen für Schiffsmaschinen). C. Strebel. Illustrated description of apparatus and methods for lubricating all parts of ships' engines, and for cleaning and recovering the oil. Serial. 2 parts. 6500 w. Zeitschr d Ver Deutscher Ing—Oct. 20 and 27, 1906. No. 80601 each D.

Mechanical Stoking.

Mechanical Stokers at the Electric Stations of Bercy and Vitry (Foyer Mecaniques des Usines Electriques de Bercy (Paris) et de Vitry (Seine). J. A. Lencauchez. Illustrated description of the Düsseldorf system of mechanical stokers and grates, at electric stations in and near Paris, with results of tests. 1500 w. Génie Civil—Oct. 27 1906. No. 80627 D.

Rolling Mill Engines.

Heavy Duty Rolling Mill Engines. Illustrated description of roughing mill engines representing the most modern practice for this class of work. 1000 w. Ir Age—Nov. 1, 1906. No. 80153.

Selection.

Selection of a Steam Engine. Chas. L. Hubbard. Gives a classification, discussing each, and the principles of their operation; and the things to be considered in selecting an engine for stated requirements. 3000 w. Elec Wld—Nov. 3, 1906. No. 80259.

Turbines.

The Development and Present Status of the Steam Turbine in Land and Marine Work. E. M. Speakman. An interesting review of the present development, considering their adoption for a variety of service, their power, and related matters. 5 plates. 11000 w. Trans Inst of Engrs & Shipbldrs in Scotland —Oct. 23, 1906. No. 80703 N.

Steam Turbine Characteristics. Hans Holswarth. Gives examples illustrating the practical use of the logarithmical p-v diagram, all the computations having been made with a five-inch slide rule. 4000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80530 C.

The Erection of Two Large Steam Turbines. A. G. Christie. An illustrated detailed account of the methods used for overcoming difficulties in handling and assembling the heavy parts, with the minimum expense of time and trouble, in erecting the large turbines of the Brooklyn Rapid Transit Co., at the Williamsburg power house, and the Gold Street power house of the Edison Ill. Co. 2000 w. Sib Jour of Engng—Nov., 1906. No. 80414 C.

The Steam Turbine. A. H. Gibson. Considers the lines along which the turbine has been developed, the advantages and disadvantages of the types thus far evolved, and the directions in which future developments may be looked for. 3000 w. Cassier's Mag—Nov., 1906. No. 80210 B.

The Steam-Turbine of the Allgemeine Electricitats-Gesellschaft, Berlin. O. Lasche. Abstract translation of a paper read in June, 1906. Illustrated descriptions of the building of the Curtis turbine in Germany. 3500 w. Engng—Nov. 16, 1906. No. 80730 A.

The Melms & Pfenninger Steam Turbine (500-K. W. Dampfturbine, Bauart Melms & Pfenninger). M. Schröter. Illustrated description of steam turbine driving two 250-kilowatt dynamos, and full account of tests. Tables. Serial. 1st part. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 10, 1906. No. 80616 D.

MISCELLANY.

Aeronautics.

The Ader "Avion." From the French of Maurice Degeorge in *L'Automobile*. Reviews the experiments made by M. Ader, illustrating his inventions. 1500 w. Sci Am Sup—Dec. 1, 1906. No. 80738.

The Parseval Dirigible Airship. Dr. Alfred Gradenwitz. Illustrated description, with general remarks on airships. 1500 w. Sci Am—Nov. 10, 1906. No. 80273.

Band-Saw.

Special Band-Saw for Ripping Deck-Planks. Illustrates and describes a new machine for re-sawing wide planks into deck planks of various widths. 1100 w. Engng—Nov. 9, 1906. No. 80494 A.

Calculating Machine.

An Ingenious Calculating Machine. Henry J. Kennedy. Illustrates and describes a machine which with any digit multiplier, requires but one turn of the crank to obtain the product. 6000 w. Am Mach—Vol. 29. No. 44. No. 80170.

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Glass Manufacture.

The First Machine for the Commercial Production of Window Glass by the Sheet Process. An illustrated article describing the manufacturing methods that have been employed and an invention of Irving W. Colburn for drawing glass of any reasonable width and of desired thickness, surface and polish. 2500 w. Sci Am—Dec 1, 1906. No. 80736.

See also Mechanical Engineering, Heating and Cooling.

Index.

A Mechanical Engineering Index. W. W. Bird and A. L. Smith. Explains the building of a comprehensive Mechanical Engineering Index with a minimum of time. In use at the Worcester Polytechnic Institute. 7000 w. Pro Am Soc of Mech Engrs—Nov., 1906. No. 80526 D.

Memoranda.

Memoranda for Engineering Data. T. S. Avely. Gives specimen result tabulations, which may be amplified to suit any conditions. 700 w. Prac Engr—Nov. 9, 1906. Serial. 1st part. No. 80472 A.

Nurnberg Exposition.

Transportation and Machinery at the Bavarian Centennial Exposition at Nuremberg, in 1906 (Das Verkehrs-und Maschinenwesen auf der Bayerischen Jubiläums-Landesausstellung zu Nürnberg, 1906). Kurt Hering. Illustrated description of exhibits. The present number is devoted to railways and locomotives. Serial. 1st part. 2000 w. Glasers Ann—Nov. 1, 1906. No. 80611 D.

Stenophile.

A Shorthand-Writing Machine. Dr. Alfred Gradenwitz. Brief description of the machine invented by Bivort, of Paris, to which the name "stenophile" has been given. 500 w. Sci Am Sup—Dec. 1, 1906. No. 80740.

Traction Engine.

A Novel Snow Locomotive. Illustrates and describes a traction engine built for logging service in Wisconsin. 300 w. Ry Age—Nov. 2, 1906. No. 80239.

MINING AND METALLURGY

COAL AND COKE.

China.

Coal Deposits and Methods of Mining in China. Eliot Blackwelder. A sequel to a review of the geology and early development of coal mines in China. 1100 w. Min Wld—Nov. 24, 1906. No. 80598.

Coke Ovens.

Coke Ovens and Coking. J. Martin van Harlingen. An explanation of the method of coking in the bee-hive or round oven with air partially excluded. Ills. 2500 w. Yale Sci M—Nov., 1906. No. 80566 C.

An Innovation in Coke Ovens. Illustrates and describes a new type of oven at the Mt. Braddock plant, near Uniontown, Pa. It possesses unusual features and claims a saving in labor, time, and cost. 1000 w. Ir Trd Rev—Nov. 22, 1906. No. 80551.

Coking.

Coke and Coking Coals. J. Martin van Hartingen. Considers the composition of coals, showing that they vary widely. 1200 w. Yale Sci M—Oct., 1906. Serial. 1st part. No. 80157 C.

Colorado.

Coal Mining in Colorado. J. E. Hanes and F. W. Parsons. Illustrates and describes the methods used in operating the Delagua mine, which is the largest in the state. 2000 w. Eng & Min Jour—Nov. 24, 1906. No. 80587.

Courrieres Disaster.

Courrières Colliery Disaster. Abstract of the report issued from the Home Office on the disaster which occurred at Pas-de-Calais, France, on March 10 of this year. 3800 w. Col'Guard—Oct. 26, 1906. No. 80305 A.

The Courrières Disaster. James Ashworth. A review of the Commissioners' Report on this mine disaster and its probable cause. Ills. 3000 w. Engr, Lond—Nov. 9, 1906. No. 80501 A.

Mine Fire.

Extinguishing a Mine Fire. William Taylor Heslop. A record of experience in dealing with an underground fire at St. George's Colliery, Natal. 2000 w. Mines & Min—Nov., 1906. No. 80193 C.

Montana.

Coal Resources of Montana. Jesse Perry Rowe. Information concerning the coal properties, the quality of the coal, and the output. 1200 w. Min Wld—Nov. 24, 1906. No. 80700.

Production.

Output and Value of Coal in 1905. Extracted from the "General Report and Statistics Relating to Mines and Quarries." Confined to the countries of the United Kingdom. 1800 w. Col Guard—Nov. 9, 1906. No. 80492 A.

Transvaal.

The Transvaal Coal Industry. A M'Arthur Johnston. Information concerning the coal mines and their working, the output, quality of the coal, etc. 1800 w. Min Wld—Nov. 17, 1906. No. 80460.

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COPPER.

Analysis.

The Knorr Method of Determining Arsenic and Antimony in Refined Copper. P. Butler. Describes a method originated by A. E. Knorr. 700 w. Min Rept—Nov. 8, 1906. No. 80382.

Argentine.

New Enterprise in Old Field. Information concerning an enterprise for the working of copper mines in the Andes, on the line between Argentine and Chile. 2000 w. Min Jour—Nov. 10, 1906. No. 80489 A.

Chile.

The Copper Deposits of Collahuasi, Chile. José Muro. Describes the reopening of these old mines, the deposits, and their working. 1000 w. Min Jour—Nov. 10, 1906. No. 80490 A.

Idaho.

The Priest Lake Mining District, Idaho. William M. Courtis. Information concerning a new copper district. 600 w. Eng & Min Jour—Nov. 10, 1906. No. 80366.

Moss Copper.

Moss Copper on Matte. Charles S. Palmer. A study of copper mattes and the making of moss copper. 1600 w. Min & Sci Pr—Nov. 17, 1906. No. 80735.

Smelting.

The Wallaroo Smelting Works. T. C. Cloud. Gives details with regard to this plant in South Australia, and the method of working. These works at present turn out between 6,000 and 7,000 tons of refined copper annually. 7000 w. Inst of Min & Met—Bul No. 26. Nov. 8, 1906. No. 80564 N.

Virginia.

The Copper Deposits of Virginia. Thomas L. Watson. An illustrated article describing the character and occurrence of the ores, with notes on past production. 3000 w. Eng & Min Jour—Nov. 3, 1906. No. 80251.

GOLD AND SILVER.

Assay.

The Assay of Antimonial Gold Ores. William Kitto. States the methods tested, giving the conclusions from the experiments. 1500 w. Inst of Min & Met—Bul No. 26. Nov. 8, 1906. No. 80563 N.

Australia.

Charlotte Plains Consolidated. Reviews the history and gives an illustrated description of this great alluvial mine in Victoria, and of the methods employed. 4800 w. Aust Min Stand—Oct. 3, 1906. No. 80338 B.

China.

Gold Mining at Wei-Hai-Wei, China. W. Denham Verschoyle. Describes an ore deposit and the mining conditions. Ills. 2000 w. Eng & Min Jour—Nov. 17, 1906. No. 80439.

Cobalt.

The Nipissing Mine, Cobalt, Ontario. H. C. George. Map, with description of occurrence and methods of prospecting and mining. 800 w. Eng & Min Jour—Nov. 24, 1906. No. 80586.

Cobalt. Fritz J. Frank. Illustrated description of this successful silver camp in Ontario, Canada; its geological features, ores, methods of hydraulic prospecting, etc. 2500 w. Mines & Min—Nov., 1906. No. 80190 C.

The Cobalt, Ontario, Mining Craze. J. A. McDonald. Briefly reviews the history of this district, its present condition, and the value of the properties developed. 1100 w. Eng News—Nov. 1, 1906. No. 80180.

Colorado.

The Gunnison Gold Belt of Colorado. Arthur Lakes. Brief illustrated description of peculiar features of this region. 1000 w. Min Wld—Nov. 10, 1906. No. 80381.

Dredging.

The Weaver Dredging System for the Recovery of Fine Gold. Describes this system which is meeting with marked success in Idaho. 1500 w. Min Rept—Nov. 1, 1906. No. 80244.

A New American Gold Dredge. Illustrates and describes details of the bucket used in a new dredge of the elevator type. 1200 w. Eng News—Nov. 1, 1906. No. 80177.

Flotation Processes.

The Flotation Processes at Broken Hill. Donald Clark. Brief notes on the Potter process, the Delprat, the De Bavay, and the granulation process. 9000 w. Eng & Min Jour—Nov. 24, 1906. No. 80585.

Zinc and Lead Sulphide of Broken Hill, Australia. W. Burrell. Describes the Potter and other flotation processes of separation. 1500 w. Mines & Min—Nov., 1906. No. 80191 C.

Hydraulic Mining.

The Rehabilitation of Hydraulic Mining. J. P. Hutchins. Considers the steps now in progress to restore California's gold washing industry to its former importance, without interfering with agriculture. 1500 w. Ills. Eng & Min Jour—Nov. 10, 1906. Serial. 1st part. No. 80369.

Kalgoorlie.

Records and Progress of Kalgoorlie, Western Australia. Ralph Stokes. An illustrated article giving authoritative facts in regard to Kalgoorlie and Coolgardie 1700 w. Min Wld—Nov. 24, 1906. No. 80597.

Mexico.

The Pinguico Mine, Guanajuato, Mexico. John A. Church. Describes the interesting geological features of this district, and the occurrence of ore. Con-

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siders this vein as a deposition of ore, carrying gold and silver, in a fault in a massive bed of rhyolite. 2500 w. Eng & Min Jour—Nov. 24, 1906. No. 80583.

Milling.

Milling Gold Ores. Algernon Del Mar. Considers the objects sought in milling operation and the machines in use for their accomplishment. 2000 w. Min & Sci Pr—Nov. 17, 1906. No. 80734.

Nevada.

The Johnnie Mining District of Nevada. W. A. Root. An illustrated account of these gold mines, the transportation facilities, and matters of general interest. 2500 w. Min Wld—Nov. 24, 1906. No. 80599.

New Zealand.

The Economic Possibilities of the Hokitika Sheet, North Westland Quadrangle, New Zealand. Considers the economic possibilities of this district, especially the minerals, which include auriferous and platiniferous veins, gold-bearing gravels, greenstone, talc, coal, clays for brick making and stones for ornamental and building purposes. 3500 w. Min Jour—Nov. 17, 1906. No. 80723 A.

Placers.

Gold Washing in the South. E. B. Wilson. Describes some crude methods which succeed where expensive outfits would fail. 900 w. Eng & Min Jour—Nov. 17, 1906. No. 80442.

Queensland.

Mount Langen, Upper Brisbane Valley. Lionel C. Ball. Describes gold, silver, and bismuth prospecting areas. 5000 w. Queens Gov Min Jour—Sept. 15, 1906. No. 80287 B.

Samplers.

Some Tailing Samplers. R. Gilman Brown. Illustrates and describes two practical machines for this work which have stood the test of long operation. 600 w. Min & Sci Pr—Nov. 3, 1906. No. 80384.

Slimes.

The Tavener Process. L. A. E. Swinney. Gives in detail the working of this process for the smelting of zinc gold slimes. 2800 w. Inst of Min & Met—Bul No. 26. Nov. 8, 1906. No. 80565 N.

Stamp Mills.

Masonry Foundations for Mortars of Stamp Mills. Arthur B. Foote. Describes three mills observed by the writer, and describes their behavior with continual service. Favors masonry foundations properly constructed. 1500 w. Eng & Min Jour—Nov. 10, 1906. No. 80370.

IRON & STEEL.

Africa.

A Native Steel-Smelting Village in West Africa. An interesting account of the methods adopted in the village of Olaigbi. 5000 w. Sci Am Sup—Nov. 10, 1906. No. 80277.

Australia.

Iron and Steel Manufacture in Australia. Describes the Heskett-Moore process—a method for directly converting iron ore into malleable iron or steel by a continuous system. 1500 w. Queens Gov Min Jour—Sept. 15, 1906. No. 80286 B.

Bethlehem.

The Bethlehem Steel Company's Recent Extensions. Illustrated description of the new Saucon plant at South Bethlehem, Pa., and the shapes to be rolled. 4000 w. Ir Age—Nov. 1, 1906. No. 80154.

Biwabik.

The Iron Mines at Biwabik, Minn. This is one of the big mines of the Mesabi. Other properties in the vicinity are also described. Ills. 1800 w. Ir Trd Rev—Nov. 1, 1906. No. 80165.

Constitution.

Prof. Heyn's Experiments on the Tempering and Annealing of Steel (Les Expériences du Prof. Heyn sur la Trempe et le Revenu des Aciers). F. Osmond. Discussion of experiments to determine troostite and sorbite and other constituents of steel. Diagrams and tables. 2500 w. Rev de Métallurgie—Nov., 1906. No. 80636 E + F.

Electric Furnace.

The Production of Iron in the Electric Furnace (Die Herstellung von Roheisen im Elektrischen Ofen). Fritz Cirkel. Review of experiments made by Dr. Haanel at Sault Ste. Marie. Tables and illustration. 1000 w. Stahl u Eisen—Nov. 15, 1906. No. 80680 D.

Grading.

The Grading of Pig Iron for the Foundry. A discussion of the system of pig-iron classification in use in England, considering the varying nature of the product, and the unreliability of fracture as an indication of the quality of the iron. 2400 w. Engng—Nov. 16, 1906. No. 80724 A.

Hungary.

The Metallurgical Works of the Austro-Hungarian Railway Co. at Resicza and Anina, Hungary (Die Hüttenwerke der Priv, Oesterreich-Ungarischen Staats-Eisenbahngesellsschaft in Resicza und Anina, Ungarn). F. W. Lürmann. General review of these large coal, iron and steel works, and their products, with plans. 1500 w. Stahl u Eisen—Nov. 15, 1906. No. 80679 D.

Ingots.

Crystallization and Segregation of Steel Ingots. Summary of the results of about 30 years as given by J. E. Stead in two recent addresses on the above subject, and the conclusions from his own investigation. 2600 w. Ir & Coal Trds Rev—Nov. 2, 1906. No. 80363 A.

Joliet.

The Illinois Steel Company's Joliet Extensions. Illustrated description of the

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new blast furnace, nut and bolt shop, and rail joint plant. 2500 w. Ir Age—Nov. 15, 1906. No. 80385.

The Joliet Plant of the Illinois Steel Co. An illustrated article describing recent improvements and additions, comprising a new 500-ton blast furnace, a nut and bolt mill and a rail joint plant for continuous and Wolhaupter joints. 3000 w. Ir Trd Rev—Nov. 15, 1906. No. 80395.

Magnetic Concentration.

Notes on Some Recent Experiments on the Magnetic Concentration of Iron Sands from the Lower St. Lawrence. John F. Robertson. Abstract of a paper before the Can. Min. Inst. Describes experiments made to cheaply overcome the difficulties due to the low percentage of iron and the presence of a much greater amount of titanium than is considered permissible. 2200 w. Min Rept—Nov. 8, 1906. No. 80383.

Magnetite.

Magnetite Mines at Lyon Mountain, N. Y. D. H. Newland and N. V. Hansell. Illustrates and describes this district, its geology, nature of the ore and methods of mining. 2800 w. Eng & Min Jour—Nov. 10, 1906. Serial. 1st part. No. 80365.

Malleable Iron.

Beginning of American Malleable Iron. Gives the history of the work of Seth Boyden, and those associated with him, and of the early experiments in the Newark, N. J., foundry. Ills. 2800 w. Ir Trd Rev—Nov. 8, 1906. No. 80316.

Metallography.

Metallographic Investigations in Foundry Work (Metallographische Untersuchungen für das Giessereiwesen). E. Heyn. Address before the German Foundrymen's Convention on the constitution of iron, with diagrams and micrographs. Serial. 2 parts. 6000 w. Stahl u Eisen—Nov. 1 and 15, 1906. No. 80674 each D.

Nitrogen.

Nitrogen in Iron (Ueber die Bedentlung des Stickstoffes im Eisen). Hjalmar Braune. An address before the "Jern-Kontoret," in Sweden, giving the results of chemical and physical researches into the effects of nitrogen on iron. Ills. Serial. 1st part. 3500 w. Stahl u Eisen—Nov. 15, 1906. No. 80678 D.

MINING.

Arizona.

Metallurgical Plants and Practices of Yavapai, Arizona. An illustrated report of the plants and improved methods introduced. 2000 w. Min Rept—Nov. 1, 1906. No. 80243.

Comstock.

Unwatering the Comstock Lode. Illustrates and describes an electrical pumping plant installed in Ward shaft. 1000 w. Eng & Min Jour—Nov. 24, 1906. No. 80584.

Damages.

Recent Litigation Involving Questions of Damages from Smelter Fumes, Tailings Water, and Tailings Debris. F. W. Traphagen. Read at Denver meeting of the Am. Min. Cong. Considers two suits before the United States Court in the state of Montana. 1700 w. Min Rept—Nov. 1, 1906. No. 80245.

Drainage.

Mine Drainage Districts. D. W. Brunton. Read before the Am. Min. Cong. Discusses the advantages of a common drainage system wherever possible. 1200 w. Min Rept—Nov. 15, 1906. No. 80457.

Drilling Oil.

The Drilling of an Oil Well. A brief outline of the manner of obtaining this liquid wealth in California. 1800 w. Cal Jour of Tech—Nov., 1906. No. 80413.

Electric Power.

Modern Electric Switching and Mining Locomotives and Cars. Frank C. Perkins. Illustrates and describes some recent types of electric shunting and mining locomotives and electric dump cars. 3500 w. Elec Engr, Lond—Nov. 2, 1906. No. 80349 A.

Explosives.

Inquiry re "Bobbinite" by British Home Office. James Ashworth. Considers the characteristics of various flameless explosives, reporting tests of bobbinite and other explosives. 4800 w. Mines & Min—Nov., 1906. No. 80196 C.

Explosions.

The Relation of Barometric Pressure to Mine Explosions. F. W. Parsons. A suggestion that explosions of gas may be guarded against by attention to meteorological conditions. 1200 w. Eng & Min Jour—Nov. 17, 1906. No. 80440.

Haulage.

Mules vs. Electric Locomotives. W. F. Murray. Presents the comparative merits and costs of the mine mule and the electric locomotive. 1000 w. Eng & Min Jour—Nov. 24, 1906. No. 80588.

Mine Air.

Witwatersrand Mine Air: Recent Investigations. James Moir. Briefly explains a method of testing the air, invented for the use of Inspectors of Mines, giving results obtained. 3500 w. Jour Chem Met & Min Soc of S Africa—Sept., 1906. No. 80470 E.

Missouri.

Mining and Milling at Fredericktown, Missouri. Robert B. Brinsmade. Describes the mines, deposits, and methods of stoping in clay ores, crushing, jigging, etc. The deposits contain copper, nickel and cobalt sulphides associated with the galena. Ills. 3500 w. Mines & Min—Nov., 1906. No. 80192 C.

Safety Appliances.

New Safety Appliances for Mines (Nouveaux Dispostifs de Sécurité dans les

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Mines). Henri Mamy. Illustrated description of automatic barrier and derail for mine railways and brake for hoisting machinery. 1200 w. Génie Civil—No. 10, 1906. No. 80631 D.

Timbering.

Mine Timbering at Lake Superior. W. R. Crane. A discussion of the application of various systems. Ills. 1200 w. Eng & Min Jour—Nov. 10, 1906. No. 80367.

Square-Set Timbering at Bingham, Utah. Claude T. Rice. Illustrated description of a new method of framing, in use at Bingham, Utah, with brief criticism of the system. 1200 w. Eng & Min Jour—Nov. 3, 1906. No. 80250.

Tube Mills.

The Computation of the Crushing Efficiency of Tube Mills. S. H. Pearce and W. A. Caldecott. Describes the method used. 1500 w. Jour Chem, Met & Min Soc of S Africa—Sept., 1906. No. 80471 E.

Ventilation.

Underground Fans as Main Ventilators. Alfred J. Tonge. Abstract from the *Trans.* of the Inst. of Min. Engrs. Describes an installation in an English colliery which has proved successful, and explains conditions under which they may prove more economical than fans at surface 4500 w. Mines & Min—Nov., 1906. No. 80194 C.

MISCELLANY.

Chili.

The Present State of Mining and Metallurgy in Chili (Le Chili Minier et Metallurgique au Point de Vue le Plus Recent). Ch. Vattier. A general review of the whole country, taken province by province. 8000 w. Mem Soc Ing Civ de France—Sept., 1906. No. 80632 G.

Corundum.

Corundum in Ontario. D. G. Kerr. Read before the N. of England Inst. of Min & Mech. Engrs. Describes the occurrence, mines, mill, etc. 4000 w. Can Min Rev—Nov., 1906. No. 80518 B.

Deposits.

About Mineral Belts. Theo. F. Van Wagenen. Calling attention to the metal-producing belts, running parallel with each other, and conclusions drawn. 1700 w. Min & Sci Pr—Oct. 27, 1906. No. 80240.

Microscopic Examination of Nickeliferous Pyrrhotites. William Campbell and C. W. Knight. Gives results of a study made to settle a much discussed question in ore deposition. Ills. 3000 w. Eng & Min Jour—Nov. 17, 1906. No. 80438.

Education.

See Industrial Economy.

Iceland.

The Geological Features of Iceland. L. P. Gratacap. Map and illustrated description of this interesting island. 3000 w. Min Wld—Nov. 17, 1906. No. 80458.

Mercury.

The Reduction of Quicksilver Ore. Frank J. Booth. A general criticism, based on a working experience with retorts. Ills. 1800 w. Min & Sci Pr—Nov. 10, 1906. No. 80397.

Metallurgy.

Recent Progress in Metallurgy. Alexander E. Outerbridge, Jr. A résumé of the most notable achievements in metallurgy during the past year, showing the great advance in the production of metals. 8300 w. Jour Fr Inst—Nov., 1906. No. 80407 D.

Mineral Waters.

The Genesis of Mineral Waters. Etienne A. Ritter. A summary of a paper by Armand Gautier in *Annales des Mines*, discussing their relations to volcanic action and the formation of ore deposits. 2200 w. Eng & Min Jour—Nov. 10, 1906. No. 80368.

Molybdenum.

A Rapid Method of Determining Molybdenum. James Darroch and C. A. Meiklejohn. Describes an adaptation of the molybdate method of estimating lead, which gives excellent results, both with ores and ferro-molybdenum, stating its advantages. 1000 w. Eng & Min Jour—Nov. 3, 1906. No. 80249.

Phosphate.

The Clarendon Rock Phosphate Deposit, Near Milton, Otago. Arthur Andrew. Describes three deposits, discussing their origin, describing the mining methods and subsequent treatment. 4200 w. N Z Mines Rec—Sept. 17, 1906. No. 80339 B.

Platinum.

Methods of Extracting Platinum. F. W. Horton. Describes the various methods used for the mining and recovery of platinum. 3000 w. Ind Wld—Nov. 3, 1906. No. 80222.

Potash.

The Slassfurt Salt Industry. W. C. Blasdale. Describes the deposits and process of manufacture in operation at a mine in New Stassfurt, Germany. 3000 w. Cal Jour of Tech—Nov., 1906. No. 80412.

Pot-Roasting.

The Pot-Roasting of Ore. Leonard S. Austin. Describes this process which is coming into increasing use. Ills. 1200 w. Min & Sci Pr—Oct. 27, 1906. No. 80241.

Pyrometer.

An Electric Recording Pyrometer. Illustrated description of a pyrometer of the thermo-electric type, designed by William H. Bristol. 800 w. Sci Am Sup—Nov. 10, 1906. No. 80278.

Tin.

The York Tin Region of Alaska. Frank L. Hess. An account of the geology, topography, ore deposits and working mines of the region, with a forecast of the future output. From an official examina-

tion just made for the U. S. G. S. by the writer. 5500 w. Engineering Magazine—Dec., 1906. No. 80695 B.

The Tin Deposits of the Carolinas. Abstract of a bulletin, prepared by L. C. Graton, concerning the location and production of these mines, the size, extent, and economic importance of the deposits. 1300 w. Ir Age—Nov. 1, 1906. No. 80156.

Tin in the Black Hills, South Dakota. Franklin R. Carpenter. The writer believes that tin-mining in this district will soon rank second to gold mining, and gives his reasons for the opinion. 2500 w. Min Wld—Nov. 17, 1906. No. 80459.

Wyoming.

The Present Status of Wyoming Mining. Henry C. Beeler. Reports progress and encouraging outlook for the low-grade copper and gold ores of this state. 1500 w. Min Rept—Nov. 15, 1906. No. 80455.

Zinc.

Canadian Zinc Production. Review of the report of the Commissioner appointed to investigate the zinc resources of British Columbia, and their commercial possibilities. 3300 w. Can Min Rev—Nov., 1906. No. 80517 B.

Production of Zinc in the United States. From advance sheets of the U. S. Geol. Surv. Gives the estimated production of the Rocky Mountain states and other information relating to zinc ores. 2200 w. Min Rept—Nov. 15, 1906. No. 80456.

The Ferrocyanide Method for the Determination of Zinc. W. H. Seamon. A study of the conditions that influence the determination. 1800 w. Min Wld—Nov. 3, 1906. No. 80242.

Zinc Analysis.

Technical Estimation of Zinc. Charles E. Rueger. Gives methods for attaining more exact results in zinc analysis. 2000 w. Mines & Min—Nov., 1906. No. 80195 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Railway Bridge Floors and the Atlantic City Disaster. Editorials discussing the leaving of the bridge floor without inside guard rails, and the failure to have the signals so connected as to indicate the position of rails. 4000 w. Eng News—Nov. 8, 1906. No. 80334.

Rails and Rail-Lifts on the Thoroughfare Draw Near Atlantic City, N. J., Newfield Branch of West Jersey and Sea-Shore R. R. Illustrated detailed description of the mechanism of this drawbridge, where a train was recently derailed and plunged into the water. 1800 w. Eng News—Nov. 15, 1906. No. 80451.

The Atlantic City Disaster. Report of the decision of the coroner's jury concerning the cause of the derailment on the drawbridge of the West Jersey & Seashore, at Atlantic City, N. J., Oct. 28, 1906. 1000 w. R R Gaz—Nov. 9, 1906. No. 80329.

The Best Safeguard Against Woodstock Disasters. A. M. Wellington. Reprinted from Eng. News. of Feb. 12, 1887. Describes and illustrates the improved Latimer re-railing bridge safety guard. 700 w. Eng News—Nov. 8, 1906. No. 80336.

British Freight.

The British System of Cartage and Delivery of Freight at Terminals. An illustrated article showing the methods of the London and North Western Railway, the types of vehicles employed for cartage, and the magnitude of the work. 1800 w. R R Gaz—Nov. 23, 1906. No. 80570.

Ceylon.

The Passenger Service on the Ceylon Railways. Messrs. Blum and E. Giese, in *Zeitung des Vereins.* An interesting account of these railways and their equipment and proposed new lines. 2000 w. Bul Int Ry Cong—Nov., 1906. No. 80743 E.

Conference.

Second Conference for the Revision of the International Convention on the Transport of Goods by Railway. A report of the business transacted. 7700 w. Bul Int Ry Cong—Oct., 1906. No. 80393 E.

High-Speed.

Recent High-Speed Trials of Steam Locomotives. Translated from *Zeitung des Vereins.* A report of recent trials with steam locomotives running long distances. 2900 w. Bul Int Ry Cong—Nov., 1906. No. 80742 E.

Single Track.

Single Track Train Operation on the Wheeling & Lake Erie. Gives an interesting chart showing graphically the extra and regular trains run on Sept. 2, 1906, and giving information. 700 w. R R Gaz—Nov. 23, 1906. No. 80571.

MOTIVE POWER & EQUIPMENT.

Brakes.

Recent Progress in the Air Brake Art. Robert Burgess. An illustrated paper considering progress in locomotive brake equipment and car brake equipment, followed by general discussion. 11700 w. Pro S & S-W Ry Club—Aug., 1906. No. 80282 E.

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The Kapteyn Apparatus for Recording Continuous Brake Trials. A. Fuhr, in *Annualen für Gewerbe und Bauwesen.* Illustrated detailed description of this new apparatus under trial on the Prussian State Railways. 2500 w. Bul Int Ry Cong—Nov., 1906. No. 80741 E.

The Maximus Brake. Illustrated description of a brake designed to give a pressure which shall vary with the speed. 600 w. Engr, Lond—Nov. 9, 1906. No. 80503 A.

Car Cleaning.

Car Cleaning. B. P. Flory. Discusses the subject of terminal car cleaning only, the methods and cleaners. General discussion. Ills. 12000 w. Pro N Y R R Club—Oct. 19, 1906. No. 80404.

Car Heating.

Heating of Trains on the Hermes-Beaumont Railway (Le Chauffage des Trains sur les Lignes Exploitées par la Compagnie du Chemin de Fer de Hermes à Beaumont). Mons. Dupriez. Illustrated description of system of heating by steam from the locomotive, on meter-gauge railways in northern central France. 2500 w. Rev Gén des Chemins de Fer—Nov., 1906. No. 80640 G.

Cars.

Private car for the Western Union Telegraph Company. An illustrated article describing the special features of this car. 500 w. Ry Mas Mech—Nov., 1906. No. 80373.

35-Ton Steel Underframe Stock and Coke Car. Illustrated detailed description of cars for the A. T., and S. F. Ry. 500 w. Am Engr & R R Jour—Nov., 1906. No. 80267 C.

Van for Motor Cars. Brief illustrated description of a car used on the Caledonian Ry. for carriage of automobiles. 500 w. Ry & Loc Engng—Nov., 1906. No. 80230 C.

Cast Steel.

Experience with Cast Steel Parts on Locomotives of the Northern Railway of France (Essai de Pièces en Acier Moulé par la Compagnie du Chemin de Fer du Nord). Mons. du Bousquet. Brief record of favorable experience, with illustration. 500 w. Rev Gén des Chemins de Fer—Nov., 1906. No. 80638 G.

Steel Castings in Locomotive and Car Construction. J. V. McAdam. Briefly considers what has been accomplished in making intricate steel castings for cars and locomotives, and the changes due to their use. 2200 w. Sib Jour of Engng—Nov., 1906. No. 80415 C.

Center of Gravity.

Center of Gravity of a Locomotive—Simple Method of Determining. G. R. Henderson. Describes a simple and practical method. 700 w. Am Engr & R R Jour—Nov., 1906. No. 80268 C.

Electrification.

Electrification of the West Jersey and Seashore Railroad. Illustrated description of the new system put in operation on this branch of the Pennsylvania R. R. The present number deals with the power-house and sub stations. 2500 w. Elec Rev, N Y—Nov. 3. 1906. Serial. 1st part. No. 80255.

The Electrical Equipment of the West Jersey & Seashore Branch of the Pennsylvania Railroad. Illustrated detailed description of the equipment of this line, changed from steam to electricity. A third-rail system with low voltage. 7500 w. St Ry Jour—Nov. 10, 1906. No. 80321.

Electrical Equipment of the West Shore. An illustrated account of the equipment of a section of the West Shore R. R., between Ithaca and Syracuse, for electrical operation. 1600 w. Elec Ry Rev—Nov., 1906. No. 80422.

Electrical Power vs. Steam Power in the Operation of Railroads. E. W. Farnham. Considers this subject, especially as applied to heavy traffic lines, passenger and freight, suburban and interurban lines, and large terminals. General discussion. Ills. 10800 w. Pro W Ry Club—Oct. 16, 1906. No. 80403 C.

Energy Necessary for the Electrical Operation of the Swiss Railways (L'Energie Nécessaire pour l'Exploitation Electrique des Chemins de Fer Suisses). Prof. Wyssling. Report to a commission for the study of this question. Tables. Serial. 2 parts. 5500 w. Bull Tech d l Suisse Romande—Oct. 25, Nov. 10, 1906. No. 80643 B.

Fuel.

Combustion of Fuel in Relation to Locomotive Firing. The first of a series of articles presenting scientific facts relating to fuels and the combustion process, showing their relations to the operation of locomotive firing. Ills. 1000 w. Ry Mas Mech—Nov., 1906. Serial. 1st part. No. 80372.

Inspection Car.

Track Inspection Car of the Baltimore & Ohio. Illustrated detailed description of the car, giving a section of the record made. 1800 w. R R Gaz—Nov. 2, 1906. No. 80204.

Locomotive Boilers.

Locomotive Boilers with Combustion Chambers. Illustrates and describes designs in which this type of boiler was used, reporting their efficiency, and giving general information. 4000 w. Eng News Nov., 1906. No. 80554.

Locomotive Failures.

Engine Failures and Their Causes. F. P. Roesch, at Chicago meeting of the Trav. Engrs' Assn. Discusses the construction, repairs, and handling of en-

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gines. Ills. 2000 w. Ry & Loc Engng—Nov., 1906. No. 80228 C.

Locomotives.

Locomotives at the Liége Exposition in 1905 (Les Locomotives á l'Exposition de Liége, 1905). A. Herdner, with note by A. Mallet. Very complete, illustrated review of the steam locomotives at Liége, and their parts and operation. 4 plates. 40000 w. Mem Soc Ing Civ de France—Sept., 1906. No. 80633 G.

Locomotives at the Milan Exhibition. Charles S. Lake. Illustrated description of the 4-cylinder express passenger locomotives for the Hungarian and Belgian State Railways. 1400 w. Mech Engr—Nov. 17, 1906. No. 80711 A.

Narrow-Gauge Locomotives at the Milan Exhibition. A narrow-gauge, eight-wheel coupled engine, fitted with Schmidt superheater is illustrated and described. 500 w. Engng—Nov. 9, 1906. No. 80498 A.

Balance Compound Prairie Type Locomotive with Inclined High Pressure Cylinders. Engines for fast freight service on the A., T. & S. F. Ry are described and illustrated. 1200 w. Am Engr & R R Jour—Nov., 1906. No. No. 80270 C.

Birmingham Southern 2-8-0. Illustration, with description, of engines for use on a road in Georgia. 500 w. Ry & Loc Engng—Nov., 1906. No. 80227 C.

Cole Four-Cylinder Balanced Compound Pacific Type Locomotive. Illustrated description of engines for the Northern Pacific Ry. They are the heaviest of the type ever built. 1800 w. Am Engr & R R Jour—Nov., 1906. No. 80266 C.

Culm Burner for the D. & H. Illustrated description of consolidation locomotives designed for slow-freight and pushing service. 800 w. Ry & Loc Engng—Nov., 1906. No. 80229 C.

Four-Cylinder Compound Six-Coupled Locomotive for the Austrian State Railways. Brief illustrated description. Plate. 400 w. Engng—Nov. 16, 1906. No. 80729 A.

Four-Cylinder Compound Ten-Coupled Locomotive; Milan Exhibition. Illustrated detailed description. Plate. 1000 w. Engng—Oct. 26, 1906. No. 80308 A.

Heavy Mogul Locomotive for the Vandalia. Illustrated description of the heaviest mogul (2-6-0) locomotives yet built. In working order they weigh 187,000 pounds each. 500 w. Ry Age—Nov. 16, 1906. No. 80461.

Locomotive Development on British Railways. The first of a series of critical articles on modern practice in locomotive development. 2000 w. Engr, Lond—Nov. 16, 1906. Serial. 1st part. No. 80732 A.

New Designs of Locomotives. Illustrates and describes two recent locomotives built in England; one of 4-6-0 type, the other 4-4-0 type. 1000 w. Mech Engr—Nov. 10, 1906. No. 80473 A.

Mogul Locomotives for the Philippine Railway. Illustrated description of narrow gauge (3 ft. 6 in.) engines intended for mixed passenger and freight service. 600 w. Ry Age—Nov. 16, 1906. No. 80462.

Motor Cars.

Motor Cars for Railways (Neueres über Triebwagen für Eisenbahnen). Hr. Guillery. Descriptions of steam, benzine-electric, gasoline-electric and other self-propelled cars for railways, with discussion of experience in many parts of the world. 3500 w. Glasers Ann—Nov. 1, 1906. No. 80610 D.

Steam Rail Motor Car for the Lancashire and Yorkshire Railway. Illustrated description. 500 w. Engng—Nov. 2, 1906. No. 80357 A.

Repair Parts.

Finished Repair Parts for Locomotives. Harrington Emerson. Discusses the manufacture of new engine repair parts or the repair of old ones, considering the saving of engine delays, standardization, costs, storage, and the possibility of buying such parts in the open market. 1600 w. R R Gaz—Nov. 23, 1906. No. 80573.

Valve Gear.

The Walschaerts Valve Gear in the United States (La Distribution Walschaerts aux Etats-Unis). Mons. Sauvage. Notes on the use of this locomotive valve gear. 1100 w. Rev Gén des Chemins de Fer—Nov., 1906. No. 80639 G.

The Mathematical Analysis of the Walschaert Valve Gear. Edward L. Coster. Analysis with diagrams, also showing how the motion can be approximately represented by Zeuner's valve diagrams. 1200 w. Am Engr & R R Jour—Nov., 1906. No. 80269 C.

NEW PROJECTS.

Tehuantepec.

The Tehuantepec National Railway. Late facts in regard to the present state of this route which will give a line of communication between the Atlantic and Pacific, and its connections with steamships on both oceans. Two maps. 2500 w. R R Gaz—Nov. 9, 1906. No. 80330.

Virginia.

The Tidewater-Deepwater Railway. Begins an illustrated description of a line under construction to carry coal from the mines of West Virginia to tidewater at Norfolk. 1200 w. Ry Age—Nov. 23, 1906. Serial. 1st part. No. 80701.

PERMANENT WAY & BUILDINGS.

Curves.

The Theory of Transition Curves (Zur Theorie des Uebergangsbogens). Alfred Wessely. Mathematical discussion of transition curves between tangents and circular curves on railways, and of

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superelevation of the outer rail. Diagrams and tables. 2000 w. Zeitschr d Oest Ing u Arch Ver—Nov. 9, 1906. No. 80624 D.

Electric Power.

Electrically-Operated Traveling Platforms, Turntables and Winches. Dr. Alfred Gradenwitz. Illustrates and describes typical electrically-driven platforms, turntables and winches designed for the Potsdam railway workshops. 800 w. Sci Am Sup—Nov. 3, 1906. No. 80189.

Foremen.

The Foreman—His Training, Work, and Relation to Railroad Maintenance of Way Organization. S. W. Kapp. Briefly discusses the points named. 5600 w. Pro Engrs' Club of Phila—Oct., 1906. No. 80235 D.

Haarlem Terminal.

The Building, Equipment and Operation of the Railway Terminal at Haarlem, Holland (Verbouwing, Inrichting en Exploitatie van het Station, Haarlem). L. C. Westhoff. Address, giving an illustrated description of track work, bridge, viaduct, station, etc., with discussion. 7000 w. Ingenieur—Oct. 27, 1906. No. 80645 D.

Oil House.

Oil House. Illustrated description of the oil house of the D., L. & W. Ry. at Scranton, Pa. 1000 w. Ry Mas Mech—Nov., 1906. No. 80371.

Shops.

Organization and Economy in the Railway Machine Shop. H. W. Jacobs. Fourth number of this series. Showing how standardization of the small-tool equipment and its manufacture in the central shops will check extravagance and waste and promote economy and efficiency over the whole road. Special attention is given to high-speed steel and the redesign of machines, and many examples are shown. 3000 w. Engineering Magazine—Dec., 1906. No. 80694 B.

Railway Shops on the Prairie. Brief illustrated description of the Canadian Pacific Shops at Winnipeg, Man. 1500 w. Ry & Loc Engng—Nov., 1906. No. 80226 C.

Signalling.

Automatic Electric Block Signalling. Illustrated description of the signal installation for the electrified lines of the Long Island Railroad. 900 w. Ry Age—Nov. 23, 1906. No. 80702.

Electrically-Operated Points and Signals at Didcot. Illustrated description of an important installation on the Great Western Ry., operated by electricity. 2000 w. Engng—Oct. 26, 1906. Serial. 1st part. No. 80306 A.

Signal Wire.

Railway Signal Specifications for Rubber Insulated Wire. Gives the specifications for rubber-insulated signal wire for 600 volts or less, submitted to the Railway Signal Assn. 900 w. Elec Wld—Nov. 10, 1906. No. 80374.

Station.

The New Goods Station at Newcastle. Illustrated description of an example of monolithic ferro-concrete construction, built by the North-Eastern Ry. Co. 4000 w. Engr, Lond—Oct. 26, 1906. No. 80309 A.

Terminal.

A New Seaport. Ralph H. Rockwood. Illustrates and describes the new tidewater terminal of the Bangor & Aroostook R. R., at Stockton Springs, Me. 700 w. Ry Age—Nov. 2, 1906. No. 80236.

Tracks.

Best Method of Maintaining Track for the Tonnage and Speed of To-day. A committee report presented to the Chicago convention of the Roadmasters' and Maintenance-of-Way Association. Recommendations relating to foundations, drainage, ballast, ties, curves, etc. 2800 w. R R Gaz—Nov. 23, 1906. No. 80572.

STREET AND ELECTRIC RAILWAYS

Accidents.

A Board of Trade Report on an English Railway Accident: Brakes for Electric Cars on Steep Grades. Reprint, nearly in full, of a report signed by Col. H. A. Yorke, on a runaway of an electric car on a grade, which occurred on June 23, 1906, near Highgate. 6800 w. Eng News—Nov. 22, 1906. No. 80556.

Burton & Ashby.

Burton and Ashby Light Railway. Seymour Glendennin. An illustrated description of this electrically operated line. 2500 w. Bul Int Rv Cong—Oct., 1006 No. 80392 E.

Burton and Ashby Light Railway. Illustrated detailed description of the system connecting Burton-upon-Trent with Ashby-de-la-Zouch. 5000 w. Tram & Ry Wld—Nov. 1, 1906. No. 80487 B.

Counterweight.

Counterweight Device on the Balmain Tramway, Sydney, New South Wales. Percy William Shaw. Describes and illustrates a device used to secure safety and ease in operation on steep gradients. 4000 w. Inst of Civ Engrs—No. 3601. No. 80539 N.

Curves.

Tables of Car Positions on Curves. George L. Fowler. Gives tables showing

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angles subtended by cars of different lengths on curves of different radii and distances between bolster centers, and necessary distances between inside faces to allow track wheels to swing. 7 tables. St Ry Jour—Nov. 10, 1906. No. 80322.

Milan Exposition.

The Single-Phase Elevated Railway at the Milan Exposition of 1906 (Die Wechselstrom-Hochbahn auf der Internationalen Ausstellung in Mailand 1906). W. A. Müller. Illustrated description of electric railway and equipment on the Finzi system, of standard gauge and with overhead trolley wire, about one mile long. 800 w. Zeitschr d Ver Deutscher —Oct. 27, 1906. No. 80604 D.

Muncie & Portland.

The Muncie & Portland Traction Company. Illustrated description of Indiana line, mostly on private right of way, and desirably located for high speeds. 2500 w. Elec Ry Rev—Nov., 1906. No. 80424.

N. Y. Central.

Sub-Stations and Transmission System of the New York Central & Hudson River Railroad. Illustrated description. 2500 w. St Ry Jour—Nov. 3, 1906. No. 80247.

See also Electrical Engineering, Generating Stations.

Puy de Dome.

Steam Railway from Clermont Ferrand to the Puy de Dome (Tramway de Clermont-Ferrand au Puy de Dome). A. Dumas. Illustrated description of adhesion railway up this French mountain, with a maximum grade of 12 per cent. The locomotives have horizontal wheels which grip a central rail. 1 plate. 3000 w. Génie Civil—Nov. 10, 1906. No. 80630 D.

Substation Operation.

Practice versus Theory in Electric Railway Substation Operation. Sydney W. Ashe. The writer obtained employment in a substation for the purpose of investigation, and gives suggestions from the impressions gained. 2000 w. Elec Rev, N Y—Nov. 24, 1906. No. 80581.

Subway.

Proposed Subway System to Connect the Brooklyn and Williamsburg Bridges. Explains the congested conditions at these bridges, and the proposed subway system for distributing the traffic. 2000 w. St Ry Jour—Nov. 24, 1906. No. 80580.

Tracks.

On Tramway Permanent-Way Construction. Alexander Paterson, Jr. Calls attention to details in respect to packing of rails, rail-joints, and paving 3800 w. Inst of Civ Engrs—No. 3620. No. 80543 N.

Renewal of the Brooklyn Bridge Surface Tracks. Illustrates and describes some of the changes in construction aiming to provide a roadbed that will stand several years wear under the heavy traffic. 1000 w. Ry Age—Nov. 2, 1906. No. 80237.

Tube Railways.

Setting Out of Tube Railways. G. M. Halden. Remarks on street surveying, and the instruments used, with a detailed description of the setting out and construction of tube railways. 1600 w. Engr. Lond—Oct. 26, 1906. Serial. 1st part. No. 80310 A.

Vallvidrera.

The Vallvidrera Cable Railway near Barcelona (Ferrocarril Funicular de Vallvidrera en Barcelona). José Playá. Illustrated description of cable railway 2300 feet long, and rising 535 feet. From the Revista Tecnologico Industrial. Serial. 1st part. 5000 w. Energia Electrica—Nov. 10, 1906. No. 80625 D.

Vienna.

Electric Traction on the Vienna City Railway (Elektrischer Betrieb auf der Wiener Stadtbahn). Karl Rosa and Vladimir List. Well illustrated description of the Krizik system with direct current, two overhead conductors and rail neutral, which is being operated experimentallv. 3 plates. Serial. 2 parts. 5000 w. Elektrotech u Maschinenbau—Nov. 4 and 11, 1906. No. 80573 each D.

Experimental Three-Wire System in Vienna. Illustrates and describes the equipment of a three-wire direct current system. 2200 w. St Ry Jour—Nov. 3, 1906. No. 80246.

West Ham.

West Ham Corporation Tramways. Illustrated description of the new offices and car depot, with notes on the permanent way and equipment. 4000 w. Tram & Ry Wld—Nov. 1, 1906. No. 80486 B.

West Ham Corporation Tramways. Illustrates and describes the design and equipment of the new car-sheds and offices, giving information also concerning the extent of these tramways and a few details of construction. 3500 w. Elec Engr, Lond—Oct. 26, 1906. No. 80300 A.

Wheels.

The Diseases of Cast Iron Wheels. Considers diseases due to defective material, and to methods of manufacture. Ills. 3200 w. St Ry Jour—Nov. 3, 1906. No. 80248.

The Diseases of Steel Wheels. Shows that some of the troubles are very difficult to detect, but that they do not seriously menace the property equipped with such wheels. Ills. 2700 w. St Ry Jour —Nov. 24, 1906. No. 80579.

Winona.

The Winona Interurban Railway. Illustrated description of an especially well-built line in the northern part of Indiana. Elec Ry Rev—Nov., 1906. No. 80423.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*. a bi-weekly, *s-w*, a semi-weekly, *m*. a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*. semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w*. New York.
Am. Engineer and R. R. Journal. *m*. New York.
American Jl. of Science. *m*. New Haven, U. S. A.
American Machinist. *w*. New York.
Annales des Ponts et Chaussées. *m*. Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w*. Rome.
Architect. *w*. London.
Architectural Record. *m*. New York.
Architectural Review. *s-q*. Boston.
Architect's and Builder's Magazine. *m*. New York.
Australian Mining Standard. *w*. Melbourne.
Autocar. *w*. Coventry, England.
Automobile. *m*. New York.
Automotor Journal. *w*. London.
Beton und Eisen. *qr*. Vienna.
Boiler Maker. *m*. New York.
Brass World. *m* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m*. Victoria, B. C.
Builder. *w*. London.
Bull. Am. Iron and Steel Asso. *w*. Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bull. Soc. Int. d'Electriciens. *m*. Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m*. Lawrence.
Bull. Int. Railway Congress. *m*. Brussels.
California Jour. of Tech. *m*. Berkeley, Cal.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m* Toronto.
Canadian Engineer. *m*. Toronto and Montreal.
Canadian Mining Review. *m*. Montreal.
Cassier's Magazine. *m*. New York and London.
Cement. *b-m*. New York.
Cement Age. *m*. New York.
Central Station. *m*. New York.
Chem. Met. Soc. of S. Africa *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad des Sciences. *w*. Paris
Consular Reports. *m*. Washington.
Deutsche Bauzeitung. *b-w*. Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* Sc. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *m.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Electrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy, United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pac. Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanics. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.